THE

ELECTRICAL REVIEW.

VOL. XXXI. NOVEMBER 25, 1892. No. 783

CONTENTS:

	PAGE
The Thirsk Accident.—Block Signalling	621
Australian Electrical Notes	624
The Electro-Micrographical Examination of Metals and Alloys	624
The First Vacuum Lightning Protector Invented in France (*illus.*)	625
Communications from Austria-Hungary	626
Chlorine and Soda by Electrolysis	626
Changes of Conductivity in Rock Magmas.—Lines of Force ...	627
A Portable Instrument for Measuring Magnetic Fields (*illus.*)	628
Country House Lighting (*illustrated*)	629
Prizes Offered by the Society for the Encouragement of National Industry	630
The Mechanism of Diffusion	631
Reviews:—How to make Common Things	631
A Text-book of Magnetism and Electricity...	631
Die Accumulatoren für Elektricität	632
The Science and Practice of Lighting	632
The Institution of Electrical Engineers	632
Report of the Post and Telegraph Department of Queensland for the Year 1891	633
Electro-Chemical Effects on Magnetising Iron (*illustrated*) ...	634
Applications to be made to Parliament for Various Powers ...	636
Legal:—John Hopkinson *v.* The St. James's and Pall Mall Electric Light Company (*continued*)	636
Notes	640
Contracts Open and Closed.—Business Notices, &c.	644
City Notes, &c.:—The Swan United Electric Lighting Company	645
The Hove Electric Lighting Co.—Traffic Receipts	645
Share List of Electrical Companies	646
Proceedings of Societies:—Institution of Electrical Engineers	647
Electro-Metallurgy	649
New Patents.—Abstracts of Published Specifications	651
Correspondence:—The Meter for the Million	652
The Electric Light Fatality	652
Train Lighting.—Schanschieff Battery	652

J. A. BERLY'S

UNIVERSAL ELECTRICAL DIRECTORY

For 1893,

IS NOW IN COURSE OF PREPARATION.

Advertisers are respectfully requested to send in their Orders and Revised Proofs as early as possible.

Scale of charges for Advertisements and Insertions, with examples of various insertions sent, post free, on application to

H. ALABASTER, GATEHOUSE & CO.,
22, Paternoster Row, London, E.C.

THE ELECTRICAL REVIEW.

Published every FRIDAY, Price 4d.

The Oldest Weekly Electrical Paper. Established 1872.

TO BE OBTAINED BY ORDER FROM ANY NEWSAGENT IN TOWN OR COUNTRY.

OFFICE:—22, PATERNOSTER ROW, LONDON.

Telegraphic Address "AGEKKAY, LONDON." Code A B C. Telephone No. 517

ALL Letters should be addressed to the Proprietors, H. Alabaster, Gatehouse & Co.

ADVERTISEMENT RATES ON APPLICATION.

The "Electrical Review" is the recognised medium of the Electrical Trades.

SUBSCRIPTION RATES.—In *Great Britain*, Post Free, per Year, 19s. 6d. To all *Foreign Countries* (except those mentioned below), per Year, £1 1s. 8d. *Exceptions.*—Abyssinia, Aden, Borneo, Ceylon, India, Java, Labuan, Mozambique, Penang, Persia (viâ Brindisi), Phillipine Islands, Singapore, Zanzibar, to which the rates are: per Year, £1 8s, 10d.

BINDING.—Subscribers' numbers bound, including case, for 3s. 6d. each volume.

CASES.—Cloth Cases for Binding can be had, price 2s. 6d. each.

READING CASES, to hold from One to Twenty-six Numbers until the Volume is complete for Binding, can now be had from the Publishers, Price 6s., or Free by Post (in Great Britain), 6s. 6d.

FOREIGN AGENTS.—*New York:* D. VAN NOSTRAND, 23, Murray Street. *Paris:* VEUVE J. BOYVEAU, 29, Rue de la Banque. *Berlin:* ASHER & Co., 5, Unter den Linden.

Cheques and Postal Orders (on Chief Office, London) to be made payable to Mr. H. ALABASTER, 22, Paternoster Row, E.C.

THE THIRSK ACCIDENT.—BLOCK SIGNALLING.

THE jury have arrived at their verdict! The signalman is committed to take his trial; the directors of the North Eastern Railway have been stigmatised as "really responsible for the deaths of the deceased," a reduction in the hours of duty for night work in certain signal boxes, and the provision of a larger relief staff are recommended; the engine driver of the goods train is blamed; the stationmaster is censured; and surprise is expressed that no provision is made for the ready suppression of fires occurring to "trains when running."

We can readily imagine how, after having delivered themselves of such a verdict, these twelve jurors must have wended their way homewards in conscious pride at having thus "performed their duty." No half measures for such men as these! Straight at the root of the evil is their shaft levelled! True, the signalman had not been on duty 12 hours. He had not been on duty, in the signal cabin, 9 hours, yet it is the former term of duty which meets censure. Naturally, it may be argued, if a man cannot stand 9 hours, he cannot stand 12 hours. But do the facts of the case support the contention? We do not attempt to pose as legislators for the hours of duty which should be observed by any railway service, but we cannot forbear regarding this verdict in its logical sequence with the circumstances of the case. Was the company to blame for the long duty which this man, under the fortuitous circumstances by which he was unhappily surrounded, had experienced? In point of fact, what had been his duty? Was it not 12 hours in his orchard on the Monday, 12 hours in the signal cabin Monday night, 3 hours in bed on the Tuesday morning, the rest of the day, in agony of mind and distress of body, comforting and seeking aid for his wife, and then duty in the signal cabin till the result which we are now called upon to consider, occurred? In point of fact, had not the man, with the exception of the short rest which he snatched on the Tuesday morning, been on duty, of one kind or another, for some 44 hours? Were the directors responsible for this? Would the signalman himself, had he been able to foresee the domestic distress which was to happen on the Tuesday, have occupied the previous day as he did? We think not. Doubtless an 8 or 9 hours' duty in a busy main line signal cabin is long enough, but the circumstances which attended the signalman's duty on the occasion of the Thirsk accident form but a feeble case in support of this theory, for the reason that his actual duty in the signal cabin had not exceeded this limit when it occurred.

We cannot help thinking that had the jury directed their attention to other means for the prevention of similar accidents, their verdict would have been received with more general satisfaction, and that it would have carried more

weight with it than, it is to be assumed, will be the case. Had the engine-driver of the standing goods sounded his whistle, there is every probability the signalman would have been aroused from his lethargy. Had the fireman proceeded to the signal cabin, and stood there, as in duty bound, till he received orders to start, doubtless the catastrophe would never have occurred. Had the electrical block signals been interlocked with the mechanical signals, it could not have arisen.

The case is one which fully illustrates the fallibility of human nature. Worn out with fatigue—the result of distress of mind and body wholly unforeseen, and, consequently, unprovided for—the signalman succumbs to the inexorable demands of nature; the engine driver and his fireman fail to promptly comply with the company's regulations. We are all wise after the event; but, probably, there never was a case in which reliance upon human nature so utterly and thoroughly failed. Had the electrical signals been interlocked with the mechanical signals, the company would, in some measure, have been protected against this lamentable and unforeseen result; for so long as the goods train occupied the section, the line clear signal for the express could not have been rendered.

It is not the first time that we have approached this subject. On other occasions—happily, not always in connection with misadventures—we have not failed to point out the fact that worked as in general it now is, the block system is not of that value which it would be were the electrical signals interlocked with the mechanical signals, so that the one could not be worked without the sanction of the other. As matters now stand, and as is exemplified in the Thirsk case, the signalman may give the *line clear* signal for a succeeding train whilst he has another in the same section. Means of interlocking the electrical with the mechanical signals are not wanting, nor need such an addition prove a very heavy charge. It would seem clear that had the two been so combined, the Thirsk catastrophe could not have occurred, for, so long as the goods train was in the section, it would have been impossible for the Manor House signal cabin to have given the line clear signal to the cabin in the rear for the approaching passenger train. We should like to ask, would the cost of interlocking the entire block system of the North Eastern Railway amount to so much as this accident will cost the company? Doubtless, the question has been considered, not merely by the North Eastern, but by other companies; but the expense, with no such consequences before them as those which at this moment prevail, has probably been such as to cause them to defer the subject till "more opportune times." Those opportune times, we fear, will never, uninvited, present themselves; the matter will have to be dealt with, and the sooner it is taken in hand the better, and the greater will be the credit to those who deal with it first, and independent of the solicitude of the Board of Trade.

Expense is an important agent, doubtless, but that it will have to be incurred we may be assured. It will come in the form of compensation for casualties, if not in carrying out that which, once effected, may reasonably be expected to prevent casualty. Can the propriety, the desirability, of such an expenditure, effecting such results, be for one moment doubted? Once again we heartily commend the consideration of the subject to our railway friends. Certain of our prominent railways have not hitherto shown themselves averse to advancement and improvement. Are they to be outstripped by some of the smaller lines who, recognising the value of that which we have been so constant in recommending, have already protected a considerable portion of their mileage?

We wonder if it did occur to this jury, with its sweeping verdict to enquire whether, and to what extent, life was sacrificed by the burning of the vehicles engulfed in the fire which followed the collision, independent of the sacrifice arising out of the collision pure and simple? We have scanned the evidence published, but have been unable to glean that any attempt was made to do so. All we know is that certain charred remnants indicated the consumption by the fire of certain human beings. This was the consequence of the fire; but how did the fire arise, and was its fury, its extent, in any way contributed to by the form of illuminant employed for lighting the carriages? We should have imagined this was an important point, purely within the sphere of the coroner's enquiry. Happily our railway casualties have, until recently—until the Clapham Junction collision, and now this at Thirsk—been, for years, free from this additional horror. The public mind has been naturally exercised as to the extent to which it may go, and a thorough and exhaustive investigation by the coroner, who, under the powers of his court, possessed all the means for doing so, would have proved generally acceptable. We cannot help thinking that time spent in this direction would have been more profitable than in deliberating upon the provision "to trains running" of means for suppressing a fire. We should like to know how the jury, if asked, would accomplish this. Would they tack on to each train so many hundred tons of water, and so many fire engines; or would they consider the case sufficiently met by each train carrying with it a few hundred patent hand grenades? We wonder what would become of either in a collision such as that which occurred at Thirsk! Possibly we do these gentlemen an injustice. Is it that they mean railway companies should provide a constant water service throughout their systems, with hydrants at, say, every hundred yards? Possibly this is what they meant. It is of course feasible—only it would be attended with just a little expense.

We doubt not but that the two points to which we have directed attention as material to the safety of railway travelling will receive some consideration at the hands of the Board of Trade inspecting officer, and we look forward to the issue of his report accordingly.

Hysteresis.

WE have received the second part of Mr. Steinmetz's laborious investigations into the 1·6th law for hysteretic losses. The communication, which is of great length, was made to the American Institute of Electrical Engineers on September 27th of this year. It contains evidence of immense labour, but unfortunately the particulars given of the actual experimental data and methods are not quite full enough. The first thing that strikes one is that the author has quite pinned his faith to his empiric law, and to the linear reluctance law of Mr. Kennelly. The latter is well-known to be merely the inversion of the Frolich formula, and is only applicable to a certain part of the magnetic curve; rather than acknowledge that the linear relation does not hold at the superior limit, he considers that the iron used by Ewing and others (who

got values of I for cast-iron superior to those shown by his results) was of very much higher quality than his own. One interesting result obtained is that the hysteretic loss depends merely on the range of B, and not on the limits; this is rather to be expected than wondered at, at any rate below high saturations, as the magnetism always starts off along a Raleigh line at reversal. At saturation, however, or where the curve of B is nearly horizontal, it is evident that a very small area only would be enclosed by variations taking place along this part of the curve. A rather amusing part of the paper is the one headed "Conclusions and Fallacies." As far as one can understand it (and Mr. Steinmetz is sometimes very deep and German), the fallacies existed apparently in Mr. Steinmetz's brain, as they certainly were not held by electrical engineers in general. For instance, no one supposed (as the author holds they supposed) that the area of the curve connecting ampère turns and magnetism was in every case the equivalent of the iron loss; if there be a secondary circuit, Foucault currents, or any other sink or source of energy to be considered, we must find the equivalent M.M. forces before we can assert that the area represents the hysteretic losses. In many cases this would be all but impossible, but if we do so draw the curve connecting the *resultant* M.M. forces and the magnetism, its area gives the iron losses due to molecular friction; this we all know, and hence the fallacy here appears personal to the author. One of the most interesting parts of the paper deals with the magnetic properties of iron amalgam, and various heterogenous mixtures of iron filings, &c.; for all these the empiric 1·6th law holds fairly well. With regard to his own law, the author seems a bit hazy, for he says that the dissipation of energy into heat is "very likely" given by the formula

$$H = \eta \left(\frac{L_1 - L_2}{2} \right)^{1\cdot6}$$

where L is only $4 \pi I$ under a new guise. Why very likely? After so much work, it would surely have been possible to do better than "very likely." On the whole the paper contains a great deal of valuable results, but they are rather hard to unearth; the most valuable part of all is the complete set of curves given.

Cost of Gas and Electricity.

WE notice in our American contemporary, the *Engineering Magazine*, an article by Mr. C. J. Russell Humphreys, dealing with the "Relative cost of Gas and Electricity," and the conclusions arrived at are very interesting, assuming for the nonce that the premises are correct. In our own columns we have at various times dealt with this question from as impartial a standpoint as possible, and there has not yet been any reason to doubt the accuracy of our conclusions. What we were principally interested in at the time was the relative cost per hour of a modern 16-C.P. gas burner, and a 16-C.P. incandescent lamp, balanced on the photometer. The former would require 5 cubic feet of gas per hour (say in London or any of our large towns), and the latter 64 watts. In the articles in our contemporaries, however, the common basis for comparison was that of the expense of lighting a house by electricity and by gas. This is quite another relationship, and it is this question to which the writer of the article we allude to addresses himself, finally arriving at the curious result that "If gas sells for $1 per 1,000 feet, the selling price of electricity for an equivalent light must be $1.25." The basis of the argument which results in this somewhat curious conclusion, a delightful one for the contemplation of the public at large were it to represent facts, is an assumed capital expenditure on plant, &c., of $30 per 16-C.P. lamp. Now this method of obtaining figures seems to be open to considerable question, inasmuch as sufficient experience has been obtained by the supply companies to enable them to fix a fair selling price, and it is that price with which we have to deal and not with assumed capital expenditure. Mr. Humphreys has given himself considerable unnecessary trouble, for the prices charged in any given locality for electric energy and for gas are public property and beyond question, whereas all such comparisons based on supposititious capital expenditure lend themselves to conclusions according to the bias of the writer. In this country we have, by the action of the Board of Trade, no need to deal with fancy figures as is the habit of writers in the American exchanges, for we have data in our hands which represents within a small limit of error what may be expected from electric supply stations generally. Our American cousins are fond of mighty enterprises and great deeds—and words—but unfortunately for the "Poor man's light" (*vide* Mr. Preece), we in this country are unable to emulate the splendid results achieved on paper—in the States.

Is the Electric Discharge Oscillatory?

IN the experiments by Hertz on electrical oscillations, and also in the experiments of subsequent investigators in the same field of research, Ruhmkorff coils have been used to propagate the electrical oscillations. It is well known, however, that the oscillations in the sparks from a Holtz machine or a Leyden jar are far more rapid than those produced by the aid of a Ruhmkorff coil. Toëpler, therefore, has endeavoured to study electrical oscillations by the aid of a Toëpler-Holtz machine, and with success. During his experiments he was led to examine the electric spark between a conductor and a surface of water, and he discovered that a spark under these conditions does not oscillate. He has therefore deduced the conclusion that it is extremely probable that the ordinary lightning discharge does not oscillate. A loud noise and a strong development of light in an electric spark are held by Toëpler to be not in general criteria of the oscillatory character of the spark.

The effects of Self-Induction and Distributed Static Capacity in a Conductor.

THE solution obtained some time ago by Lord Kelvin for the variation of the current and the potential at different points in a conductor possessing static capacity, is given by Mascart and Joubert (*L'Electricité et le Magnétisme*, Vol. i., sec. 233), and is treated at length by Mr. T. H. Blakesley, in his book on alternating currents. A further contribution to our knowledge of this subject has recently been made by Drs. F. Bedell and A. C. Crehore, in a paper in which they give the solution for the case of a conductor, possessing self-induction as well as distributed capacity, and in which they note the effects produced by the introduction of the self-induction. Their work has been done at the Physical Laboratory of the Cornell University during the past few months, and the paper in which they have arranged their results, and which is of a strictly mathematical character, has been published in the American *Journal of Science*, Vol. xliv., series iii., No. 263, pp. 389—391. In concluding this paper, the authors make the interesting observation that the difference in the rates of propagation and decay of waves of high and low frequency, doubtless constitutes the limitations to the use of the telephone. As the several harmonic components of a complex tone advance along the conductor, they keep shifting their relative phases according to the difference in their rates of propagation, and also change their relative intensities according to the difference in their rates of decay, thus changing the resultant combination tone and materially altering its quality. These effects are always present in circuits containing distributed static capacity, but are not so marked when there is also self-induction.

AUSTRALIAN ELECTRICAL NOTES.

[FROM OUR OWN CORRESPONDENT.]

THERE seems to be a slight revival of electrical matters at present, or, at any rate, a "bit of a kick," as there are several contracts which have either lately been let, or are now being decided. They are mostly small, but contractors just now are glad enough to get anything which enables them to keep their hands going. Messrs. Anthony Hordern & Co., who have recently completed some new premises, are considering how they are going to light their new additions. They have decided that they are to be lit electrically, but are disturbed as to the best method of doing the construction work; there appears to be a kind of hankering after a try to do it themselves. If they do finally decide on such a course of action, I suppose that if it is a success, we shall have Messrs. Anthony Hordern & Co. taking up installation work as part of their "Universal Provider" business. The building to be lit is a comparatively large one, and will probably require about 1,000 16-C.P. lamps to light it thoroughly, the kind of contract that is much sought after just now. Then there is the lighting of the docks at Cockatoo Island, the letting of which is not yet quite decided, but is generally considered to be a certainty for the Brush Company, as out of four tenders sent in only one complied with the requirements laid down in calling for them; and the only one that was not informal was that sent in by the Brush Company. The Brush Company have in hand the Lyceum Theatre and the lighting of the new pilot boat, which includes in its fittings a powerful search light. The contract for a smaller steamer, which is to be used as a ferry boat, has gone to the Electrical Material Company.

Most of the recent electrical activity appears to have been in Adelaide. On September 12th last an experimental trip was made of a train, lighted by the Brush Electric Company, on the system which seems to have been largely adopted in Europe, of running the dynamo from the car axle, such as is in use on the London, Brighton and South Coast Railway, Great Northern, and Midland Railways. The Brush Company have taken a contract to run the plant for one train for the space of six months, the company bearing the cost of maintenance; but if, during that term, it meets with the approval of the Railway Commissioners, they will bear the cost of fitting up. Should the light fail on six occasions, the commissioners have the option of breaking the agreement. The system used comprises a dynamo driven from the axle of the van, in combination with a set of accumulators. The dynamo is fixed to the floor at one end of the brake van, and is driven by belting from a pulley fixed on the axle of the bogie wheel. In order to maintain constant tension on the belt, and to allow for variations due to the displacement of the axle when the train is passing round a curve, the belt passes over a pair of guide pulleys fixed above the dynamo in vertical slides, and provided with springs on the under side, which act against the tension of the belt. The accumulators are also fitted in the van, as are likewise all the controlling and regulating apparatus. The dynamo, of course, revolves in the same direction as the direction of the train, reversing in direction as the train reverses. In order that as little thinking as possible should be left to the guard, who is not supposed to be a specially skilled man, a number of automatic appliances are attached to the dynamo. While the train is at rest the brushes are not in contact with the commutator, and any current required is taken from the accumulators. When the train starts again, the brushes are automatically brought to the proper position on the commutator by means of a special lever enclosed in a box at the end of the armature shaft; at the same time connections are made so that a current passing round the field magnet coils gives them the requisite polarity to suit the direction of rotation of the armature. No current is taken from the dynamo until the train attains a speed of 10 miles an hour, and the dynamo a speed of 500 revolutions. At that speed, a connection is automatically made between the dynamo and accumulators, so that a current is sent round the field magnets of the dynamo, exciting them, and, at the same time, the lever at the end of the armature shaft brings the brushes on to the commutator. When the dynamo is giving its correct E.M.F., by means of another automatic appliance, the accumulators are switched into the charging circuit. The charging goes on as long as the minimum speed of the train is not less than 10 miles an hour; when it drops below that, the automatic appliances act again to reverse the operations, and cut the dynamo off and transfer the lamps entirely to the accumulators. Hand switches are provided for the guard to enable him to stop the charging, if necessary, or to disconnect the accumulators altogether if required, and to perform all such necessary operations as switching on and off the lights, as, for instance, when going through a tunnel in the daytime. With regard to the fitting up of the coaches, each compartment is lit by two 5-C.P. lamps, with reflectors and clear glass globes; connections between coaches being made by means of spring couplings, somewhat similar to the Westinghouse brake couplings. At both ends of the coach are little boxes of wood, containing switches for controlling the lights in each coach, enabling half or all the lamps in any coach to be turned on or off. The centrifugal governor, &c., have already been described, I believe, in your columns. The dynamo used is a Brush machine, giving 57 volts and 65 ampéres, and occupies a space of about 6 feet by 1 foot 6 inches. The battery consists of 24 cells of 23 L-plate E P.S. type, and weighs 228 lbs. This train is now running regularly on its six months' contract trip, and up to the present has given every satisfaction.

Attention is also being turned to the "City of Churches" just now, on account of the presentation of the Electric Lighting Committee's report to the Municipal Council on the tenders recently submitted to them for consideration. The report is practically that of Mr. Todd, Postmaster-General and Superintendent of Telegraphs, and Mr. Langdon, City Surveyor, who were asked by the committee to examine and report on the tenders for them.

A. C. F. W.

Sydney, *October* 10*th*, 1892.

[Our correspondent here follows on with information exactly similar to that which we published in our issue of October 28th, 1892, see page 530.—EDS. ELEC. REV.]

THE ELECTRO-MICROGRAPHICAL EXAMINATION OF METALS AND ALLOYS.

ABOUT seven years ago considerable attention was attracted to a new method of examining iron and steel, based upon the behaviour of these substances when dissolved at the positive pole of a Bunsen cell. This method was the outcome of some observations by MM. Osmond and Werth, and exhibits an ingenious combination of electricity, chemistry, and the microscope. A full account of it is given in the *Comptes Rendus* for 1885, vol. c., p. 450; but the following is a short *précis*:—Small plates of cast steel, from 0·02 to 0·03 mm. thick, fixed to glass by means of Canada balsam, were treated with cold dilute nitric acid, when the iron dissolved, leaving a carbon compound behind. A microscopical examination of the plates showed that cast steel possesses a cellular structure, the iron occupying the interior, and the carbide of iron the cell wall. The cells unite to form groups, which, in the thin plates, are seen to be separated by empty spaces, and, therefore, possess no walls. If a bar of cast steel is dissolved at the positive pole of a Bunsen cell in dilute hydrochloric acid, the residue, consisting of small spangles, preserves the original form. These spangles form a network, the meshes of which are filled with iron. If a polished surface of cast steel is etched with concentrated nitric acid, the dendritic structure of the cell groups is seen. In tempered steel, only simple cells are found. The interior of the cells is elongated by hammering, and the cell walls, which are but little extensible, more or less obliterated.

These researches, which have been fairly fruitful in result, have induced Mons. G. Guillemia to undertake similar investigations on non-ferruginous alloys. He finds that when the polished surfaces of alloys are attacked by dilute acids while under the influence of a feeble electric current (2 volts and $\frac{1}{10}$th ampère) they develop characteristics which are ex-

ceedingly useful for purposes of comparison, identification, &c. After this effect had been produced by the mutual action of the acid and the electric current, the corroded surfaces were examined microscopically.

The figures or etchings obtained are always the same for the same alloy, and they may be preserved for reference by photography.

The corroded surfaces consist of furrows more or less twisted, and separated by ridges which represent material that has been spared by the acid. Doubtless, at the moment of solidification the fluid metallic material had separated into many simple alloys of definite compositions which are unequally attacked by acids. This has been demonstrated by Mons. Riche (*vide Ann. de Chim. et de Physique*, XXX., 1873). By microscopical examination of the corroded surfaces they may at once be referred to a small number of classes. Thus, among bronzes and brasses we can distinguish those with a base of tin, the phosphor-bronzes, brasses containing less than 37 per cent. of zinc, "Muntz metal," and analogous alloys containing over 37 per cent. of zinc, aluminium bronzes, aluminium brasses, "Delta metal," "Roman brass," &c.

In white alloys with a base of tin, antimony, and copper, known as "antifriction alloys," the presence of lead can easily be recognised, and even, with practice, something near the proportions.

In examining ingots of red copper from the same fusion, but of different pourings, those which are properly refined can be distinguished, whilst others in which the refining is not complete, can be classed according to their degree of advancement.

It is known that the mechanical qualities of brasses and bronzes are much modified by the addition of very small quantities of aluminium or of phosphorus. The chemistry of such "traces" has been much studied by Prof. Roberts-Austen, whilst this physical influence, especially in regard to electrical conductivity, has received attention from the brothers Le Chatelier, Osmond, and others. The presence of traces of these metals is at once recognised by the electro-micrographical method of examination, since the furrows have the forms of veins of marble, or to use another geological illustration, of conglomerate, when aluminium is present; whilst phosphorus produces in bronze containing tin, a characteristic image or etching resulting in appearance a fern leaf, which is seen more clearly near the outer margin than in the centre, and which, no doubt, indicates differences of composition, due to different periods of cooling, as shown by Mons. Riche (*loc. cit.*).

The presence of 4 per cent. of zinc in a bronze has been discovered by Mons. Guillemia to mark the micrographic action of phosphorus. Further, for a given alloy, the "micrographies," as he calls the images, indicates not only the circumstances of casting, but also the nature of the operations to which it has subsequently been exposed; whether it has been poured too hot or too cold; if it has been stamped or rolled; and if rolled, in which direction the power has been applied.

Altogether, this new method of examining alloys and metals is extremely elegant and instructive, whilst not the least remarkable feature about it is the manner in which chemical action is linked with electric current, and their joint effect determined by the aid of the microscope.

International Society of Electricians.—The opening meeting of the International Society of Electricians, Paris, took place November 9th, 1892. This first meeting presented no special features, which was, perhaps, owing to the fact that M. Clémançon had promised to open a discussion with regard to the electrical apparatus required for the distribution of light and power, and was at the last moment unable to do so. M. Mascart announced that the subscription towards the Central Electrical Laboratory amounted to more than 100,000 francs; operations could, therefore, be commenced immediately. M. Picou made some remarks with regard to the daily rendering of transformers and the means of increasing it. M. G. Trouvé described the small luminous fountains that he is now constructing.

THE FIRST VACUUM LIGHTNING PROTECTOR INVENTED IN FRANCE.*

By A. M. TANNER.

VACUUM lightning protectors are just now receiving a good deal of attention in the United States, and several communications have appeared in the *Electrical Engineer* with regard to the priority of invention of these instruments. Amongst other facts, it is mentioned that C. F. Varley employed a vacuum tube as a lightning protector for submarine cables about 1872. But a French patent shows that Bianchi constructed a vacuum lightning protector as early as 1854; the priority of this invention belongs, therefore, to the French engineer. As the patent has not been printed, we have had to make a copy of the manuscript deposited at the Conservatoire des Arts et Métiers, which copy we reproduce below.

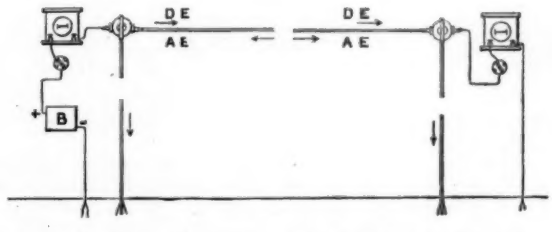
Copy of the 15 *years' patent taken out by Urbain Barthelemy Bianchi, mechanical engineer*, 15, *Rue de la Sorbonne, Paris* (No. 19,594).

Dated May 15*th*, 1854, *for an apparatus and processes intended to protect telegraphic apparatus from the disturbing influences of atmospheric electricity.*

Introductory Remarks.—The gravest objection raised against electric telegraphy is, that it cannot withstand the disturbing influence of atmospheric electricity, which acting on the conducting wires of the line affects the instruments, and gives erroneous indications if even it does not destroy them and causes serious accidents, of which the operators may be the victims.

It is to guard against this, that I propose to place along the conducting wires traversed by the electric current, instruments calculated to give the electricity known as static or high tension electricity, an outlet to convey it to earth without thereby hindering in these same wires the regular action of the dynamic current generated by the galvanic battery used for telegraphic despatches.

Principle of the Apparatus.—This apparatus is based on the property, peculiar to static electricity, of discharging itself at a distance under the influence of points, and more effectually in vacuo, of flowing freely when the points are of metal and fixed to an armature, also of metal, ending without any break of continuity in damp earth, and at the same time allowing the dynamic current of the battery, which only acts by contact and is propagated from point to point along the metallic wire of the line, to circulate freely without being influenced by these points which it does not touch, so that no derived current can be produced.



D, E, Dynamic electricity; A, E, Atmospheric electricity; B, Battery.

FIG. 1.—APPARATUS FOR PROTECTING TELEGRAPH WIRES FROM THE DISTURBING ACTION OF ATMOSPHERIC ELECTRICITY.

Description of the Apparatus (figs. 1 and 2).—This apparatus consists of a sphere of copper, *c*, through which passes the wire of the circuit, P, P′, and held in the centre of another sphere of glass, formed of two hemispheres, H, H′, connected by a large ring of copper, O, which is provided on its inner surface with equidistant points, S, S′, the number of which may vary according to the dimensions of the apparatus, and which are directed towards the centre of the copper sphere, extending to within a short distance from its outer surface.

---

* *L'Industrie Electrique.*

Details of the Lightning Protector.—The two hemispheres, H, H′, are terminated by two sockets, D, D′, through which the wire of the circuit passes and into which it is cemented ; the bottom of the copper ring, O, is furnished with a copper tap, R, communicating with the interior of the glass sphere, H, H′, and enabling a vacuum to be produced and maintained in the apparatus. This tap is provided with a screw thread, so as to receive the metal rod which is to place the metallic

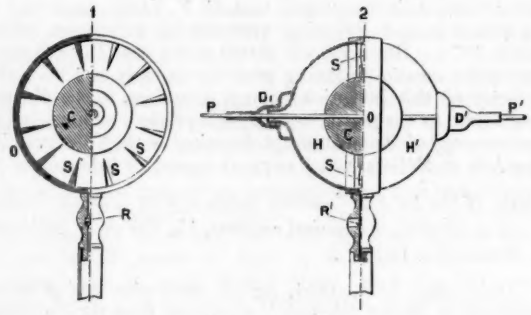


FIG. 2.—SECTION THROUGH THE AXIS.—EXTERNAL VIEW.

armature, O, in direct communication with the earth, completely insulating the wire of the circuit, P, P′, and the sphere *c*, which forms part of it.

In short, the claims of the patent are :—

1. The first idea of preserving in a battery circuit the integrity of the dynamic current, and of giving to the static electricity of the atmosphere when it acts upon it the means of passing freely to earth, without causing any appreciable hindrance to the service.

2. The arrangement of the apparatus in such a manner as to enable it to effect under the most favourable conditions the separation of the two electricities, this phenomenon being produced in vacuo.

3. The application of this idea to electric telegraphy.

COMMUNICATIONS FROM AUSTRIA-HUNGARY.

[FROM OUR OWN CORRESPONDENT.]

As regards the construction of electric tramways, there is a very active spirit of enterprise perceptible in Austria-Hungary. I gave you recently a full report on the electric railway of the mines at Bleiberg. Since then a second mining line of a similar kind has been opened in a Hungarian mine in Kis-Terenne.

This line, for electric transmission, has been executed by the firm of Ganz & Co., and is the first undertaking of the kind completed in Austria-Hungary. It is close upon 2 kilometres in length, of 620 millimetres gauge, and has an incline varying from 2 to 6·5 per cent. from the Johann shaft towards Mizserfa. It is driven by a small electric locomotive of 20,000 kilos in weight, and 6 H.P., which is only 1,050 mm. in breadth, and 1,400 mm. in height, as the line passes through two adits, which have been executed in mining dimensions. For conveying the ore dogs are used of the gross weight of 1,200 kilos. The locomotive draws from 18 to 20 of these as a train. A double aërial lead has been carried along, which, in the adits, is stretched at the height of 1,700 mm. above the metals, but 3,000 mm. in the open air. At the points some novel apparatus, has been arranged, the management of which is very simple. The working tension is 330 volts. The primary machine is in the shaft-house at the end of the line, and is driven by a 40 H.P. steam engine, constructed by the "Nordungarischen Dampfmaschinen Kohlenbergbau und Industrie Actien Gesellschaft," specially designed for the establishment of several electrical works which are in course of construction.

These works comprise a boring machine, a pump of the capacity of 1,000 litres, and a machine for driving adits.

At Smichow, near Prague, the commissional examination of a projected extended branch of the electric railway has taken place, through the Baumgarten, as far as the Bubentscher Castle. The projected line has a length of 700 metres.

In and around Budapest an entire series of electric lines for conveyance to adjacent places of resort have been projected There is also an electric lift to the Blocksberg. Similar lines are projected in Austrian and Hungarian provincial towns, and in the celebrated Hungarian watering place, Herkules-bad, an electrical local line, built by the firm Ganz & Co., is to be opened.

In Vienna, the most ancient and celebrated church, the venerable Cathedral of St. Stephen's, is provided with the electric light. The installation will be connected to the network of the General Austrian Electric Company.

The International Electric Company of Vienna, which is about to complete its second year's work, has in this time effected very satisfactory results. Already 42,000 glow lamps have been connected to its net, and 5,000 lamps are announced as being about to be joined on. The same company will shortly open the electric works at Bielitz and Biala.

The electric works of the town of Karlsbad are being considerably extended, for which an alternating current machine of 300 H.P., with the accompanying steam engine, has been ordered. Both in the Vienna works of the International Company and at Karlsbad the work is carried on by means of alternating-current machines in parallel.

As a sequel to my last report on the electric lighting of Graz, I am now able to inform you that the tender of the Gas Company (which, according to the details given you, was evidently the least advantageous in a financial point of view) has been accepted. By threatening law suits the Gas Company has secured a monopoly of public lighting for half a century.

A few days ago experiments were made at Budapest with a cab driven by electricity. The result was satisfactory.

The opening of the new telephone line Vienna-Graz-Trieste has brought to light a novel and unexplained difficulty. A duplex recently arranged on the normal conversation line does not work properly, and one of the two reserve lines has to be used almost daily. A contact with the telegraph wires seems out of the question as they pass along the railway, whilst the telephone takes the road.

CHLORINE AND SODA BY ELECTROLYSIS.*

BY E. ANDREOLI.

SOME time ago there took place an evolution in the progress of bleaching by electricity. It is not in France, nor even on the European Continent, where this sudden growth has taken place. It is in England and America where the attempts on the large scale at bleaching with electrolytic hypochlorite have been abandoned.

The reasons why the paper manufacturers have given up the use of the hypochlorite produced by electrolysis are most natural and well founded. Here are figures given by a paper manufacturer. To bleach a ton of raw alfa or half a ton of paste, 256 gallons of bleaching liquor (= 1,152 litres) at 6° Tw. are required, representing 18·7 grammes chlorine per litre. These 1,152 litres are poured into the pitcher with 2,068 gallons (= 9,361 litres) water, and of this large quantity we recover only 2,524 litres, the rest being lost in the manipulation.

If, instead, we use a hypochlorite produced by the electrolysis of magnesium chloride, the loss is enormous.

The reversed electrolysis for the recovery of the hypo-

* *Bulletin des Fabricants de Papier.*

chlorite, in addition to great practical difficulties, leads to the production of chlorate.

The Greenwood process has been attempted at the Phœnix Wharf, Battersea. This establishment is now closed, and it is not known if the Chlorine and Caustic Soda Syndicate will reopen it.

The process of Richardson and Holland is being worked by the Electrolytic Caustic Soda and Chlorine Trust, at Snodland, on the Medway.

The works there include a steam engine of 150 to 200 H.P., and a Gülcher dynamo giving 70 H.P. The salt store contains 100 tons. At the top of the works is a large tank in which the salt is dissolved with the aid of an agitator. The solution descends through pipes into a series of 10 vats, each of which is 20 feet long, 3 wide, and 9 inches deep. Each vat is divided into 60 compartments, 30 for the anodes and 30 for the cathodes. The current traversing them is 450 ampères. The electromotive force is 44 volts at the clamps of the dynamo. The loss on transmission is 4 volts. The chlorine is passed into two lead chambers where it is absorbed by lime, forming chloride of lime. The solution of soda formed at the negative pole is three times stronger than that commonly used. It is employed as a liquid, which is a great economy in fuel and labour.

CHANGES OF CONDUCTIVITY IN ROCK MAGMAS.

THE chemical composition of rock magmas, and the process and results of their crystallisation and solidification, have been studied with more or less thoroughness; but direct investigation of their physical properties has not been systematically undertaken until recently.

Analogies between the behaviour of molten rock magmas and aqueous solutions, and of metallic alloys, have been observed, and Mr. J. P. Iddings pointed out a few months ago in a paper on the origin of rocks, that an analogy exists between the differentiation of molten magmas and the concentration and partial dissociation of salts in aqueous solution.

The possibility of testing the fact of dissociation by electrolytic investigation has led Messrs. Carl Barus and J. P. Iddings to an examination of the change of electric conductivity in rock magmas of different composition on passing from liquid to solid.

The method employed was the determination of the electric resistance encountered by a current in passing through fused rock magmas, the temperature of which was gradually lowered. Although of a somewhat preliminary character, the investigation has been productive of such definite results that an account has recently been published by permission of the Director of the United States Geological Survey.

Sixteen series of electric measurements were made with three kinds of rock magmas which cooled slowly in a furnace from the molten state. Temperatures and resistances were noted simultaneously every two minutes during each series. The resistances were measured by Kohlrausch's method of intermittent currents.

The data for mean temperatures are closely accordant; but at very high temperatures, and at low temperatures, sharpness is lost, owing to polarisation, and to the immense range of electrolytic resistances encountered.

The results of the observations are plotted on a diagram, the ordinates being specific resistances in megohms, the abscissæ temperatures in degrees C., and these are then critically examined.

Without following Messrs. Barus and Iddings through their argument in detail, we may note several general deductions which may be drawn from their work.

In the first place electric conduction increases with the degree of the acidity of the magma, that is, with the degree of dilution of the cation. And since fusibility decreases in a marked way as the composition of the magma approaches pure silica, it follows that in a series of different magmas, electric conduction at any given temperature increases in proportion as the viscosity increases.

The second point gained is more specific. Conduction increases markedly from basic to acid magma. By following out certain admissible inferences, Messrs. Barus and Iddings conclude that pure silica is probably an insulator, or that it occupies a position in siliceous electrolysis very closely analogous to that of water in aqueous electrolysis.

Looking at their results as a whole, we find them touching in a novel way on the solution theories of Arrhenius, Ostwald, and Van't Hoff. Messrs. Barus and Iddings consider that it is difficult to withhold assent from the proposition that the ions of a molten magma are largely present in the dissociated state, and more especially so as very acid magmas are approached. Terms like *colloid* applied to these magmas are absolutely without relevancy; and, to the extent of this investigation, it seems that the behaviour of molten rock magmas is in its nature quite identical with that of any aqueous or other solution, the difference being one of solvent.

LINES OF FORCE.*

IN the last volume of the "Transactions of the Royal Society of Canada," Dr. A. Johnson calls attention to some of the confusion that arises from the conception of lines of force, and proposes to reject the *line* in favour of the *tube* of force, and to call the unit tube of force the "solene," from the Greek for tube, already familiar to electricians in the word solenoid. The use of Greek words savours more of pedantry than science, and "tube" is more intelligible than "solene." There is another source of confusion, however. There are two different things, called "lines of force," which should not be confounded. To go back to elementary statics, let us suppose there is a small mass of matter, M. It is regarded as sending out $4\pi m$ lines which radiate in all directions. These are frequently called lines of force. Suppose a second body, N, of mass, n, is in the neighbourhood, we can find the mutual attraction by finding how many of M's lines cut N, and how long the embedded part of each line is, and the density of the body, N, at all points. This is here stated popularly for simplicity. We can also, if we prefer it, take $4\pi n$ lines as emanating from N, and see how they penetrate M. The result is the same, of course, whichever way the problem is considered. Now take a third body, O. To find the force on it, we may take the effects of M and N separately, and combine them so as to give a resultant force, or we may plot lines so that the lines at any point represent the direction of a force that would exist if a mass were there, and their density is numerically equal to the force per unit mass. These lines are what electricians would call "lines of induction." They may be called lines of force per unit mass, but they are not lines of force; there is no force unless there is a mass there for it to act upon. Consider the field mapped out with these lines, instead of with the radiating lines which were due to a single mass. The force between M and N can no longer be found by the method just described. It has to be found by first finding where the lines enter, say M, and by squaring the density of the lines at each part of the surface, and taking the resultant of these squares. Instead of being lines of force, the lines we are now discussing represent force in direction; but the magnitude of the force varies as the square of their density. The popular notion that "lines of force" in electrical subjects, for instance, represent forces in magnitude and direction are, therefore, quite erroneous. When we insert the third mass, O, which we will consider of unit magnitude, in the resultant field of M and N, we can find the force on it by assuming that it does not disturb the field, and employing the first method, or the method of what a mathematician would call volume integrals; but we have already plotted the resultant field, so that the attraction of M and N is found by a surface integral. To be consistent, we must find the force, N O, by plotting a field as affected by M, N, and O, and taking a surface integral over O. Otherwise we are really using two in-

* *Industries.*

compatible hypotheses at the same time. The volume method is mostly employed in astronomy and statics, but electricians use the volume method whenever they deal with such things as the deflection of a galvanometer needle, or the force on a dynamo wire, but they employ the surface method when they calculate the attraction of a magnet on its armature, or the force on the disc of an absolute electrometer. In one case they use "lines of force per unit pole," or "per unit current," as the case may be; in the other case the force depends on the square of the line density.

A PORTABLE INSTRUMENT FOR MEASURING MAGNETIC FIELDS.

THE inconveniences of the ballistic method of determining the strength of magnetic fields such as are found in the neighbourhood of working dynamos are well known. Everyone will concede that portability, a considerable range, and a fair degree of accuracy, are desirable in any instrument used for making such measurements. These were the qualities which Messrs. Edwin Edser and Herbert Stansfield have endeavoured to combine in a new instrument, a description of which was given before the Physical Society, and which may be found in detail in the *Proceedings* for October.

The instrument, whilst satisfying the first of the above conditions, may be used to measure any field from one line per centimetre upwards, with an error of only about 2 per cent.; the only accessories required being a dry cell and a resistance box. In principle it is the inversion of the well-known D'Arsonval galvanometer, the torsion necessary to restore a coil, through which a constant current circulates, to its normal position, parallel to the direction of the lines of force, furnishing readings proportional to the field at the position of the coil. [The same principle has been used in some experiments of Messrs. Siemens and Halske.]

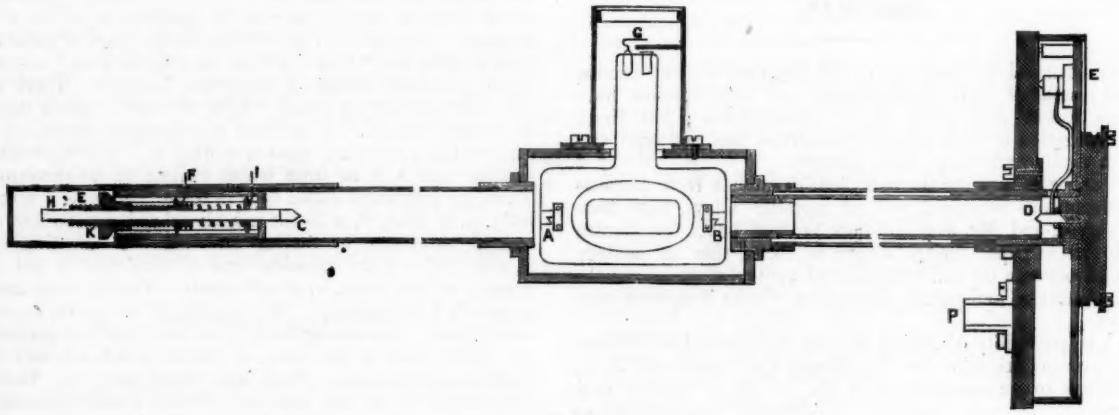


FIG. 1.

A diagram of the instrument is shown in fig. 1. A, B, is a small coil, oblong in shape, wound of No. 44 B.W.G. copper wire, and supported half on each side of a sheet of mica. It is suspended from each end by strips, 10 cm. long, of rolled German silver wire, each strip having a loop, which is passed over a small brass hook riveted on to the mica, and in electrical communication with a terminal of the coil. The strip, C, A, is in electrical connection with the case of the instrument at C, whilst the strip, D, B, is insulated from it at D by an ebonite plug attached to the torsion head, E. Inside this latter is a commutator for automatically reversing the current so as to take readings on each side of the zero. It consists of four semi-circular strips of copper, cross connected as shown in fig. 2, *a* and *b* being connected to the two battery terminals. Two springs, one soldered to the case, the other insulated from it, but connected to the end of the suspending strip, D, B, press on these semi-circular strips. When the torsion head is at zero no current passes, the springs then being at *c* and *d* respectively (fig. 2).

To take a reading the torsion head is turned, thus sending the current through the coil. Should the latter be deflected in the wrong direction, the current can be reversed by means of the plug contact, P, attached to the battery leads. Readings are taken on each side of zero in order to eliminate any error due to imperfect balancing of the coil; an aluminium pointer, G, attached to the coil, being always brought by the torsion to the zero position on a small scale. In order to obtain at once a spring suspension and an adjustment for the torsion of the strip, a particular form of geometrical slide is used, A, A′ (fig. 3), is a thick brass tube, turned at B, B′ to a slightly conical plug to fit the tube of the instrument (fig. 1). Two grooves (seen in plan at C, C′) are made along this tube, a cross head, F (fig. 1), on the screw, E, F, fitting into them. This screw is drilled along its whole length to admit a thick wire, H, I, C, the latter having a cross head, I, also fitting into the longitudinal groove. These two cross heads are then connected to the two ends of a spiral spring in such a manner that they are pressed by it against opposite sides of the grooves. The suspending strip being connected to the central wire, H, I, C, at C, its tension can be increased or diminished by means of the nut, K, without altering the position of the coil. Any sudden jerk will also be taken by the spring, thus obviating the risk of stretching the suspending strip. Scratches on the wire, H, I, C, near H, indicate the tension used.

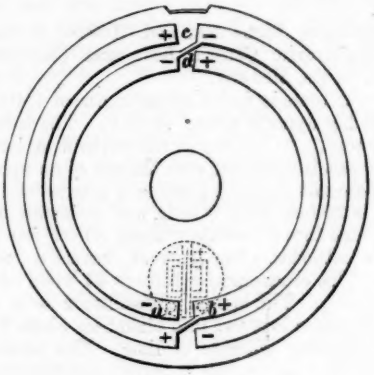


FIG. 2.

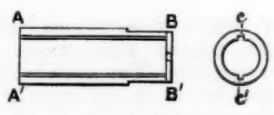


FIG. 3.

As a source of current, Messrs. Edser and Stansfield use a Hellesen dry cell. When joined up through 50 ohms, the

E.M.F. of the cell is practically constant, whilst its internal resistance is negligible (*vide Electrotechnische Zeitschift*, August 1st, 1890. Vol. ii. No. 31).

The resistance of the instrument having been made up to 50 ohms, it follows that its sensitiveness can be varied by introducing an independent resistance in the circuit.

Let c = constant of instrument (*i.e.*, field for 1° of torsion with no external resistance in circuit).
n = multiple of 50 ohms in circuit, exclusive of resistance of instrument.
θ = mean angular torsion.

Then

$$\text{Field in C.G.S. measure} = c\ (n + 1)\ \theta.$$

The paper is profusely illustrated, and gives a number of interesting results obtained in experiments with various well-known dynamos.

COUNTRY HOUSE LIGHTING.

A VERY complete installation for electric lighting and other purposes, has recently been carried out at Poles, Ware, Hertfordshire, the residence of E. S. Hanbury, Esq.

The new mansion is built on the site of the original house which was pulled down for it. The architects, Messrs. Ernest George & Peto, have treated the building in the manner of the late Tudor work. The hall has an oak beamed ceiling showing the joists, an oak staircase and minstrels' gallery occupying one end, and the ante-hall, with its oak screen, the other end.

The windows are generally kept above the high oak panelling, except the tall mullioned bay window in the centre, which has its sill near the ground. The drawing room, which is 50 feet long, has a waggon ceiling of parquet work and leads by folding doors to the library, which has a fine chimney of alabaster.

The whole of the mechanical arrangements were designed by Mr. Ed. C. de Segundo, Assoc. M.Inst. C.E., consulting engineer, who also superintended the execution of the work.

Mr. Hanbury's original intention was only to light the house electrically, subsequently, however, a high pressure fire pump was added for use in case of fire, and then by means of a line of counter-shafting, the engine was made to drive a deep well pump (bored in a convenient position in the engine room), a thrashing mill, and a large circular saw.

These additions have naturally rendered the general arrangement somewhat different to what it would have been had everything been contemplated before the engine house was designed.

In order to be prepared for a sudden demand, a quick-steaming boiler, stated to be capable of raising steam at 100 lbs. per square inch from cold water in eight minutes, was erected in the boiler room and the necessary steam pipe connection and valves so arranged that the main boiler, or the quick-steaming boiler, can be used separately or both together to drive the engine. The advantages of this arrangement are many, for, apart from the facility for raising steam at short notice, whether for the fire pump or other work, either boiler can be used while the other is under repair, and sometimes under peculiar atmospheric conditions, the draught, which is ordinarily unusually excellent owing to the great care bestowed on the shape and direction of the flue, may become such as to necessitate both boilers being steamed if an extra load on the engine should at any time be required.

The accompanying drawing, fig. 1, shows the general arrangement of the plant.

The main boiler is one of Messrs. Marshall's Cornish multitubular type, and is placed as near the chimney stack as possible. The Merryweather boiler is erected in the same room, but as near the engine as possible, a wrought-iron chimney taking the waste gases straight up through the roof.

The next room contains the mechanical plant, consisting of a Marshall engine, a Merryweather double acting fire pump and a deep well pump, which supplies water for drinking and other purposes at the mansion. This pump is arranged to deliver into a large tank in the boiler room and into a reservoir situated near the mansion. The feed tank in the boiler room is connected with an alternative means of supply in case of failure of water in the deep well. The next room is used as a workshop and stores, and next this is built a large open shed used for thrashing. On the other

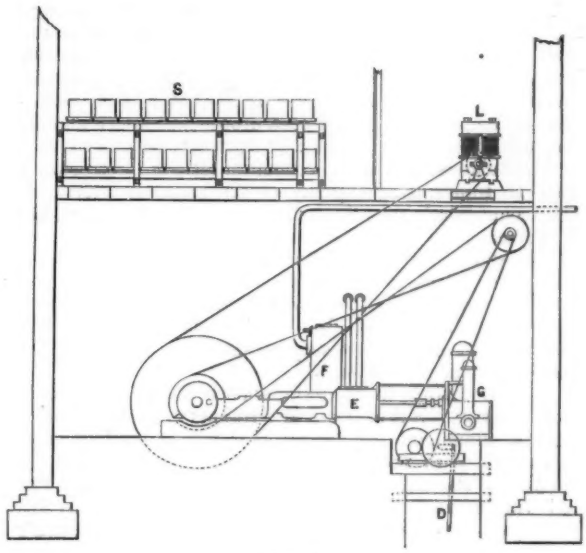


FIG. 1.

side of the boiler house a sufficient space is enclosed for a five feet circular saw and taking on and off bench. The dynamo and accumulators are contained in a room above the engine room, workshop, and entrance to the engineer's cottage.

The addition of the fire service brought with it the necessity for having the engineer always at hand, and it was decided to extend the engine house by building on a cottage for the engineer. The arrangement of communicating doors was then altered to admit of the most direct access from the engineer's bedroom to the quick steaming boiler.

The main boiler is of sufficient size to drive the engine, one of Messrs. Marshall's well known, Class C., horizontal high pressure non-condensing engines of 12 H.P. nominal, working up to 48 H.P. indicated, with a boiler pressure of 80 lbs. per square inch. The main boiler is fed by a pump on the engine, or by an injector. The feed pump delivers through a feed water heater operated by the exhaust from the engine. The injector draws direct from the tank.

The engine is fitted with Hartnell's patent governor, which, as is well known, regulates the speed by altering the travel of the expansion valve. A sight feed lubricator is fitted to the valve chest, and the valve chest and cylinder drains are taken to a steam trap of simple and ingenious design. Lugs cast on the main engine cylinder casting afford means for connection to the fire pump, on the body of which similar lugs are cast for the reception of four wrought iron ties between the main engine and the pump. The back cylinder cover is bored and fitted with a stuffing box and gland to admit a tailrod from the engine piston, which, by a very simple sleeve coupling, is easily and quickly thrown in and out of gear with the fire pump plunger. The fire pump suction is connected with a specially built sump in a pond at the back of the engine house, which was specially enlarged to hold a good supply of water for fire extinction, and the delivery is taken through six mains to the hydrants around and inside the mansion and in the farm buildings and kitchen garden. The dynamo, an 8-inch long Edison-Hopkinson shunt-wound machine, is unavoidably placed on the floor above, and is driven by a belt direct from the engine fly-wheel. Regulation is effected by a variable resistance placed in the shunt. A fixed resistance frame is provided through which the dynamo can be worked up to the proper load before switching on the accumulators, of which there are two sets of 56, 23 K E.P.S. cells arranged to work singly or in parallel as occasion may require.

The switchboard contains a seven-way regulating switch on the charging and discharging circuits, with an ampère-

meter controlled by a short-circuiting switch and voltmeter in each circuit. By means of small two-way double pole switches the voltmeters can only be used for other purposes. The cells can be coupled in parallel for charging and discharging, and the E.M.F. and current on the resistance are also measurable on the switchboard.

The mains to the mansion, which is about half-a-mile from the engine house, are taken through cast iron pipes coated with Dr. Angus Smith's special preservative compound. The insulation of the main is of the best quality and highest quantity manufactured by the India-rubber and Gutta-percha Company. A 10 per cent. drop at full load is allowed for, regulation being provided by extra end cells on each set of accumulators. Thus an economical ratio of electromotive force to transmitting capacity of the mains is arrived at. The countershaft runs through the whole engine house, and is of steel.

By a suitable arrangement of valves the exhaust from the engine can be passed through the feed water heater or direct into the chimney of the quick-steaming boiler, by which means the draught can be considerably accelerated, thus rendering it possible to keep steam when satisfying the utmost demands of the engine.

A great feature in the installation is the great immunity from fire risk. Not only has Mr. Hanbury chosen the safest possible illuminant for his mansion, but he has been at no little expense to obtain the most modern and efficient apparatus for the extinction of fire, should it break out. The following figures are taken from an experiment made by Mr. de Segundo to test the capabilities of the quick-steaming boiler and other arrangements. The alarm was rung at 1 hr. 58 min. 45 sec. p.m., when the engineer was in his bedroom. He ran through the building to the quick-steaming boiler and lighted the oiled waste and shavings always kept in the grate. He stood by till all was well alight, put a couple of shovelsful of coal on, and went to the engine to connect up with the pump. This latter operation occupied 35 seconds. In 2 minutes from sounding the alarm the needle of the pressure gauge began to move; at 20 lbs. per square inch, the steam blast was turned on, and at 2 hr. 6 min. 37 sec., the engine was started and the hydrants got to work—7 minutes 52 seconds after the alarm was sounded. It must be remembered that this experiment was carried out in the daytime; but, as Mr. Hanbury is having the men about the farm and others drilled regularly once a month, it may be assumed that even at night the hydrants should be at work within 15 minutes of the alarm of fire being raised. The foregoing shows that the arrangement is in every way eminently satisfactory, and that Mr. Hanbury is to be congratulated on the enterprising way in which he has dealt with this question, and on the success which has attended his efforts to minimise the risk of so great a calamity as a fire in a country house always proves to be under the ordinary conditions obtaining at the present time.

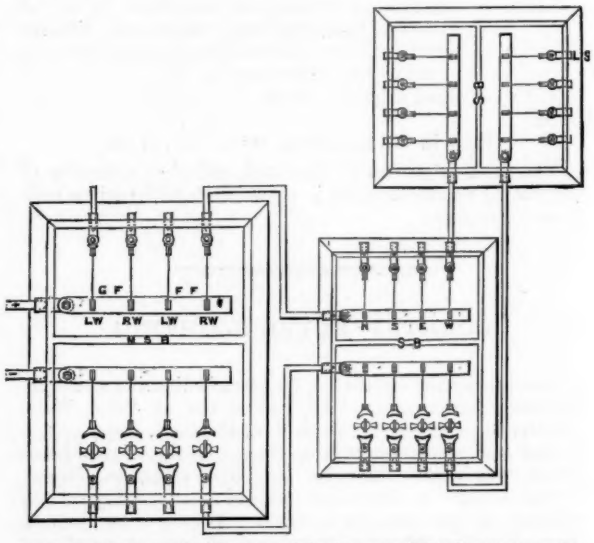
The wiring of the mansion has received particular attention, Mr. de Segundo having made a special study of the question of the wiring of houses for the electric light. In no part of any installation can attention to detail be considered superfluous, and it must certainly be obvious that a systematic and carefully followed plan of wiring, rendering the wires at all future times easy of access for examination or testing is essential to the continued efficiency and safety of an installation. This subject has been treated at length by Mr. de Segundo in a recently published pamphlet.*

The method adopted in this case is one in which subdivison is rigidly adhered to, the leading principle being to avoid as far as possible a large variation of current density in the wires, and so render the action of the fuzes much more certain. The accompanying diagram, fig. 2, clearly shows the method. From the local distributing boards a single circuit is taken for each lamp, or group of lamps, controlled by one switch. Mr. de Segundo states that from his experience he is of opinion that this principle is the only really safe one on which a house should be wired. He is also strongly of opinion that wires should never be concealed except where unavoidable, and that the installation should invariably be designed to facilitate future examination and testing.

* "Domestic Electric Lighting treated from a Consumer's Point of View." H. Alabaster, Gatehouse & Co., Paternoster Row, London.

The electric light is extended to the farm buildings and the total number of lights installed is equivalent to 350 8-C.P. lamps.

The engine house and engineer's cottage were built under the superintendence of Mr. Alexander Curror, the land steward,



G, F, ground floor; F, F, first floor; L, W, left wing; R, W, right wing; M, S, B, main switchboard; S, B, first floor right wing switchboard and first floor right wing west switchboard; L, S, to local switches.

FIG. 2.

the whole work being carried out by the staff of craftsmen employed on the estate.

Mr. Curror has built several cottages and lodges on Mr. Hanbury's property, but an engine house naturally presented several new and unusual features, and much credit is due for the accuracy and care exercised by Mr. Curror during the execution of the work.

The dynamo, switchboard, and accumulators, were supplied by Messrs. Sharp & Kent, of Westminster, who also carried out the wiring. The fittings were supplied by Messrs. Strode and Co., and by Messrs. Sharp & Kent.

The engine, main boiler, and feed-water heater were supplied by Messrs. Marshall & Co., of Gainsborough.

Messrs. Merryweather supplied the fire engine, quick-steaming boiler, deep well pump, and hydraulic work generally.

THE FRENCH SOCIETY FOR THE ENCOURAGEMENT OF NATIONAL INDUSTRY.

THE list of prizes to be awarded by the above French Society during the years 1893 to 1896 and the general conditions laid down have already been published, but the following particulars which appeared in the Society's bulletin for August, may be of use to intending competitors. We (*L'Industrie Electrique*) may also remind our readers that the limit of time during which competitions may be sent in is fixed at December 31st of the year preceding that in which the prize is to be awarded.

Prize of 2,000 *francs for the industrial preparation of ozone and for its applications.* This substance possesses advantages over chlorine in that after having acted upon organic matter, it leaves behind only inert substances, water and carbonic acid, whereas chlorine gives off hydrochloric acid, which must be got rid of, and, moreover, takes the place of hydrogen in many cases, thus causing complications which never occur when ozone is used. Therefore, a process by which ozone could economically be produced, preserved and utilised for industrial purposes is greatly to be desired, and the Society is therefore disposed to favour any effort tending to produce ozone with economy and facility, and giving the means by which this remarkable substance can be collected and preserved, so as to be used regularly for industrial purposes.

The prize is offered for a complete solution of the problem, but the Society reserves the right to encourage any serious

attempt, either at preparation or application. The prize will be awarded, if possible, in 1895.

Prize of 3,000 *francs for a substance capable of being substituted for gutta-percha in at least one of its principal applications, or for processes tending to develop the production or extend the manufacture of gutta-percha itself.*

It has been found that the supply of gutta-percha is not equal to the demand, and that, as it is used for the insulation of electric wires, the electrical industry is likely to suffer, and especially the manufacture of submarine cables, it being absolutely indispensable to their construction. Gutta-perchas of inferior quality, adulterated with other substances, are in the market, but these cannot replace the genuine article in the above applications. Attempts, which may be productive of good in the future, have been made to cultivate the India-rubber plant in a French colony, but this will not give us an immediate solution of the problem. Inventors have also tried to substitute other substances for gutta-percha, but in each case either the results have proved unsatisfactory, or the experiments have not been sufficiently prolonged. This prize was offered some years ago to any inventor who should produce a substance capable of being substituted for gutta-percha, and is now still kept on the programme and extended to any *savants* and explorers who may succeed in extending the production or manufacture of gutta-percha itself.

Prize of 2,000 *francs for an industrial apparatus or process enabling us to measure or estimate rapidly the insulation of the various parts of an installation in activity.*

This is a most important point both as regards the economy and the safety of an installation, and is of special importance to those interested in electric lighting and the transport of energy by electricity. The instruments used for telegraphy or exact measurements would be either too cumbersome, too delicate, or their manipulation would occupy too much time for the purpose required, and the indicators found in the most completely-fitted central stations only show a grave defect when it is often too late to remedy it. What is wanted, therefore, is an industrial apparatus or process enabling us to measure accurately and quickly the degree of insulation in the various parts of an electrical installation (machines, mains, transformers, &c.), and showing the variations in the insulation, thus enabling us to avoid useless losses which lessen the efficiency of a system, and also to remove a danger which is very serious in installations worked by high tension currents, especially with alternating currents, the employment of which is now being greatly extended.

THE MECHANISM OF DIFFUSION.

ARRHENIUS has lately been investigating the rate of diffusion of a large number of substances, both electrolytes and non-electrolytes, in aqueous solution, and appears to have produced, amongst others, results which at least throw some light, from a dissociationist's point of view, upon the mechanism of this little understood physical phenomenon.

When a non-electrolyte—for example, alcohol—replaces a portion of the water of a salt solution, then the rate of diffusion into the mixed solvent is less than the rate when pure water alone is used. For not too great concentrations of the non-electrolyte in water, the following relation holds good between the coefficient of diffusion and the concentration :—

$$D_x = D_o \left(1 - \frac{a}{2} x\right)^2,$$

where D_o is the coefficient in pure water, D_x that in an x-normal solution of the non-electrolyte, and a a constant depending on the nature of the non-electrolyte.

This formula is similar to that which expresses the effect of an addition of a non-electrolyte on the electrical conductivity of an aqueous salt solution, namely,

$$l = l_o \left(1 - \frac{a}{2} x\right)^2,$$

where l_o is the conductivity of the pure aqueous solution, and a an empirical coefficient, whilst x is the quantity of non-electrolyte. The coefficient, a, is very nearly the same in both these formulæ, for it is not greatly dependent on the nature of the diffusing substance.

When an electrolyte is added to the solvent instead of a non-electrolyte there is, according to the observations of Arrhenius, usually a diminution of the diffusion constant, the influence on the rate of diffusion being very similar to the influence on the fluidity. This in the paper in which Arrhenius describes this investigation is apparent from a number of tabulated results.

The mechanism of diffusion phenomena is discussed at some length in this paper; Arrhenius shows that whilst the osmotic pressure theory, as applied by Nernst, explains the observed facts, the assumption of an attractive force between the molecules of the solvent and the molecules of the dissolved substance fails to do so. He is of opinion, however, that the relation between osmotic pressure, π, and concentration, K, may best be expressed by the formula,

$$\pi = A K + B K^2,$$

where B is a constant which expresses the difference of the attractions of the dissolved for the solvent molecules, and of the dissolved molecules amongst themselves. In dilute solutions the second term vanishes, as compared with the first, and the osmotic pressure is then proportional to the concentration.

When hydrochloric acid diffuses, not into pure water, but into a solution of one of its salts, say of sodium chloride, the diffusion constant, instead of diminishing increases. Arrhenius shows that this apparently anomalous case is capable of easy explanation on the assumption of the theory of electrolytic dissociation, and, from this hypothesis, he calculates the constants for a number of similar cases.

The paper, which may be consulted in the *Zeit. Physikal. Chem.*, x., pp. 51—59, concludes with a criticism of Wiedeburg's experimental methods of studying hydro-diffusion, and with a reply to the latter's objections (*vide Ann. Phys. Chem.*, xli., pp. 675—711), against the new theory of electrolytic dissociation.

REVIEWS.

How to make Common Things. For Boys. By J. A. BOWER. London: Society for Promoting Christian Knowledge.

Although nominally a book for boys, this small work contains matter which will prove of considerable use to the older generation. Full instructions are given how to make all kinds of outdoor and indoor domestic articles, book-binding, &c., and at the latter part of the book some instructions are given for making electrical apparatus. As is often the case in books of the kind, the instructions are frequently of the nature of "much ado about nothing," and we might add "little ado about a great deal. Instance, for example, the instructions, "To make a keeper to the electro-magnet." This reads : "Get a piece of flat iron cut off long enough to extend just beyond the poles of your magnet. File it up so that the surface next the magnet is quite smooth and flat; get a screw-hole drilled into the under side, and then put a hook into it, as in fig. 144." Now as a matter of fact the glib instructions as to getting a screw-hole drilled, &c., are of no help whatever, the operation, simple as it is would be quite impracticable for a boy to effect, unless he had access to metal-working tools, in which case the instructions are perfectly unnecessary. However, in spite of these defects, the book is one of which we can speak very highly.

A text book of Magnetism and Electricity. By R. WALLACE STEWART, B.Sc., University Correspondence College Press, London, W. B. Clive & Co., 13, Booksellers Row, Strand, W.C.

This book is another of those which are continually pouring out of the press and whose existence it is difficult to justify. The work has little or no originality, it contains practically no new matter, and, in fact, is little if anything more than a re-hash of what has been done over and over again. We have no serious fault, however, to find with the composition of the volume. Mr. Stewart is a capable man and knows what he is writing about, and those who should by chance purchase the volume when making a choice from a host of others of a similar kind may rest assured that they

have not made a bad selection. We may add that the book forms a companion volume to the author's text books of Heat and Light, and is primarily written for the use of candidates for the Matriculation, Intermediate Science, and Preliminary Scientific Examinations of the University of London.

Die Accumulatoren für Elektricität. By Edmund Hoppe. Berlin: Julius Springer.

About four years ago we had the pleasure of reviewing, at considerable length, the first edition of Dr. Hoppe's treatise on accumulators. It was then, we believed, the only book on this subject written in the German language, and it was, as far as historical and theoretical data was concerned, the most complete compilation of the kind. We are now in possession of the second edition, enlarged by some 70 pages, and within these new pages we find the theories, assertions and experiences of Kohlrausch, Ayrton, Frankland, Gladstone, Hibbert, Robertson, Streintz, and Strecker. The author gives in good style and with impartiality a clear abstract of the work of each of these authorities. It is interesting to note how these physicists, and especially the pure chemists, differ in their views upon the chemical reactions which occur in secondary batteries. It would be fruitless to attempt a review of all the controversies on the chemical theories without reprinting at length the statements recorded in Dr. Hoppe's book, and we can do no more than refer the student as well as the expert to the pages of the treatise itself. The last chapter dealing with the application of accumulators to various industrial purposes has also been enlarged, but as the whole of it occupies but 60 pages, it is evident that the author's intention rests primarily in the purely scientific treatment of this most interesting subject.

The Science and Practice of Lighting. By W. H. Y. Webber. London: Walter King.

It is not often that one is called upon to notice a work dealing with the utilisation of such forms of artificial lighting as are at present most in vogue. The volumes dealing with the manufacture and distribution of the various agents employed to enable the work and pleasure of the world to be carried on after sundown are indeed a multitude, for gas and oil have received considerate treatment at the hands of those interested in these commodities, while our latest form of bottled daylight has formed a theme for a few good, several indifferent and a host of—what shall we say—would-be brilliant authors. The majority, however, are content to follow the example of the modern novelist when he leaves his heroine at the altar, and while carefully leading us up to the conversion of the material energy or kinetic energy into the wave emission we term light, bid good-bye just at the point where something of domestic utility has been provided, without dilating as to the conditions to be observed in its application to our daily needs. Beyond Mrs. Gordon's book, and one or two similar in intent, the subject is practically untreated, and those now before the public deal rather with the popular than with the technical side of the question. The work to which we now refer is a reprint of some articles which appeared in the *Journal of Gas Lighting*, and which, from their source, may be expected to have more especial reference to the science and practice of gas lighting, than to the general question as it presents itself to the unbiassed mind of to-day. While acknowledging this, the contents are of such a well considered character generally, that we can but welcome a work which will tend to draw attention to the utilisation of the light obtained from any of the common sources, gas, oil, or electricity, for it is just this portion of the field which has been passed over in too many instances by those engaged in the trade of supplying light to the public, with the dire results we see only too plainly around us. While many of the author's ideas would be benefited by somewhat maturer consideration, the conclusions are, on the whole, not far wide of the mark, and would form valuable mental pabulum for many of those who up to the present have but given full thought to the prior stages in the problem. It has just lately been appreciated that between light and illumination there exists a difference which by the many was neglected, and the attention of the electrical world has been directed to this, notably by Mr. Trotter, in his Inst. C.E. paper, the novelties of which, however, we note Mr. Webber desires to claim as his own, under the impression that these articles contain an anticipation. With this few will be inclined to agree, as few will appreciate the manner in which an attack has been made on Mr. Preece, whose views on the question of lighting are probably as advanced as an extended and carefully considered experience would admit.

The question of photometry has been ably dealt with by Mr. Dibdin and others, and is but a side issue on the main question, but not the least important article is that dealing with the photometry of lighting, inasmuch as in few other matters do so many snares and pitfalls await the unwary or beset the tyro. In addition to this, no small discretion is required to rightly interpret the results obtained in the dark room, for between candle-power on the photometer bar, and effective lighting power, there exists a relationship, into which several other questions enter in a manner calculated to mystify those who approach it purely from a practical standpoint. It is pleasing to find that our own columns have not been passed without notice, for some of the earliest references to the fallacy of assuming that good illumination necessary follows the use of high candle-power centres of light, were in the articles by Mr. Ralph Richards, whose dicta are quoted, and whose term, "optometry," was a happy thought, and one it would be well not to easily let slip. The question of street lighting has not yet received the attention which is its due, and although in this work an honest attempt has been made to open up the subject, we must confess to a feeling that much might be said with advantage as to the general problem presented by the hundreds of miles of streets, alleys and courts for which artificial illumination has to be provided for some four thousand hours a year. Those who are personally acquainted with the examples of model street lighting quoted, will endorse what is said as to the suitability of the means adopted, for by no known means could the lighting of Hyde Park corner, in London, and Lime Street, in Liverpool, be bettered without incurring an expenditure out of all proportion to the return in effect obtained thereby. While cautioning those who take up this book against a too implicit faith in the correctness of the comparisons where debatable matter is dealt with, we should not hesitate to recommend its perusal to all who are in any way connected with or interested in the questions with which it deals; and who is there not so interested?

THE INSTITUTION OF ELECTRICAL ENGINEERS.

The dinner of this society was given last Friday evening at the Criterion. The President, Prof. W. E. Ayrton, F.R.S., was in the chair, and there were also present Mr. Mundella, M.P., Sir Courtenay Boyle, Prof. W. Crookes, F.R.S., Mr. Latimer Clark, F.R.S., Mr. Preece, F.R.S., Major-General C. E. Webber, Mr. C. E. Spagnoletti, and Prof. D. E. Hughes, who are all past presidents of the society; Dr. W. J. Russell, Prof. G. F. Fitzgerald, F.R.S., president of the Physical Society, Dr. William Anderson, F.R.S., president of the Institution of Mechanical Engineers, Sir James Sivewright, Commissioner of Public Works, Cape Colony, Mr. Christie, Astronomer Royal, Sir Thomas Blomefield, Sir H. Trueman Wood, Sir Robert Rawlinson, Prof. S. P. Thomson, F.R.S., Prof. J. A. Fleming, Prof. Dewar, F.R.S., Mr. Macrory, Q.C., Sir David Salomons, Sir Henry Mance, Prof. Armstrong, Col. R. R. Jackson, Mr. Webb, secretary, and many other gentlemen.

The toast of "The Queen" was proposed by the Chairman, and drunk with all loyalty.

The next toast, "The Learned Societies," was proposed by the President, who said that some difficulty had been felt in the wording of the toast list. It was thought that to have two toasts—"The Learned Societies," "The Engineering Societies"—might suggest that the latter were not learned. (Laughter.) But the inference would be entirely wrong. There was no "and" in the matter. His friend Mr. Macrory, as a lawyer, would tell him that the French saying "none but fools and Englishmen travel first-class" was evidence that Englishmen were not fools. (Laughter.) The presence of the conjunction made all the difference. With the toast he coupled Prof. G. F. Fitzgerald, F.R.S., president of the Physical Society.

Prof. Fitzgerald, in response, said that learned societies were never more flourishing than they were now. The co-operation of theory and practice had been the fruitful parent of nearly all the advances of the present generation. We had such enormous stores of energy at our service that almost immeasurable prospects were open for the material improvement of man's estate.

Mr. Latimer Clark (past president) proposed "The Engineering Societies." He said these societies were in danger of being

overlooked. They first perfected the steam engine, then improved manufacturing implements, then the steam boat. The engineering societies had done much more to promote the great prosperity of this country than the politicians who had so wickedly usurped the greater part of the credit. (Laughter.) The great majority, unfortunately, of our countrymen believed that this prosperity was mainly due to the politicians, who attributed everything to free trade. It was due to the engineers more than to any other body that this country was the richest in the world.

Dr. W. ANDERSON responded, and said if the engineering societies were not learned they had the happy gift of appropriating for practical purposes the learning of others. The Government factories of which he was the head could speak to the way in which the labours of the chemist and metallurgist and other scientific men were utilised to practical purposes—to the great benefit of this country and, it was to be hoped, the destruction of any country which should be so ill-advised as to become involved in war with Great Britain. The mathematician also, with his infallibly accurate calculations, had to contribute his quota to the results of the department over which he presided.

The CHAIRMAN then proposed "Our Guests," with which he joined the name of Mr. Mundella, President of the Board of Trade, who exercised a sort of parental supervision over them all. No doubt sometimes there was a little disposition to grumble, as children did occasionally, at the form in which that fatherly affection displayed itself. But, whatever their feelings about the Board of Trade, there was no doubt about their feelings with respect to its President. The man who by the Electric Lighting Act, 1888, made electric lighting commercially payable was entitled to their warmest regard.

Mr. MUNDELLA, in response, said that whatever grievances the engineers might have against the politicians, his withers were unwrung. The Board of Trade might have given the electrical engineers some trouble; if so, it was not due to him. He was only newly installed (laughter)—only three months—and some of them might think he would not last much longer. (Laughter.) The President had thanked him for what he had done in 1888. But he was not then President of the Board of Trade. He had, however, learnt that the Act of 1882 was too restrictive, and required relaxation. But they had not suffered much from the Act of 1882, which was probably only a blessing in disguise, as it had enabled the engineers to perfect their methods in a manner which could not have been done before. Mr. Latimer Clark had complained of the appropriation of all the credit of material progress by the politicians. Let them halve the difference. (Laughter.) The politicians had, at all events, appointed Dr. Anderson. (Laughter.) The improvements to which Dr. Anderson had referred related to the destruction rather than the conservation of human life. But, whatever they were, the British navy had availed itself of all those appliances and had been enabled—we hoped for defence and not for attack—to perfect the methods of naval warfare more than any other nation in the world. Free trade was due to Sir R. Peel more than to any other man, and it was due to him that the energies of Watt, Arkwright, and our other great engineers had enjoyed free play for their energies. He was speaking to a comparatively young institution, but it was to one which was growing more and more, and would advance to still greater degrees of greatness. The Board of Trade owed much to the electrical engineers, who had devised systems and methods of the utmost value. It would be his duty to embody the report of the committee with respect to electrical standards in a statement to the Queen. For that report they were much indebted to the society, as they were also indebted to the distinguished German men of science, who had so greatly advanced our knowledge of electricity. But, as it would be his duty to submit to the House of Commons and the Queen the result of the labours of that committee, he could not do better than read it to them. It was in one sentence, without punctuation, and ran as follows:—"That an alternating current of one ampère shall mean a current such that the square root of the time average of the square of its strength at each instant in ampères is unity." (Much laughter.) He had asked Sir Thomas Blomefield to explain that proposition. But that candid gentleman had admitted that he knew nothing about it. Sir Courtenay Boyle was not so candid (laughter), but he suspected that his friend Sir C. Boyle knew just as much as his colleague. (Laughter.) He believed we were now at the outset of a great advance in the science of electric lighting. Progress would be assured when they could assure shareholders of a reasonable dividend. Two millions had already been expended in the metropolis, and we might soon hope to overtake the United States and Continental countries, which were, he feared, still to some extent in advance of ourselves. He hoped we should soon see the day when electricity would be the great motive power in all the work done by the nation. A marvellous change had been wrought by the introduction of the submarine cable. When he left business 20 years ago they had to wait replies for letters from Australia for three or four months. But now, in one day, all the operations could be carried through which used to require months to effect. Time and space had been annihilated. Electricity was now being used for the saving of life at sea, and Mr. Preece, one of their members, had been appointed a member of the Commission on Electric Communication with Lighthouses and Lightships. The number of lives lost in our electric systems had, he believed, only been six—an infinitesimal number compared with the loss which had been sustained in America. We had proceeded on a sound and careful system, which was economical of life, but would not fail to attain the greatest results at which it was possible to arrive. The Board of Trade had no desire to hamper the progress of electricity by needless rules, and hoped that in this, as in all other branches, science would go on its beneficent course untrammelled by any unnecessary regulations.

Sir JAMES SIVEWRIGHT, Commissioner of Public Works, Cape Colony, proposed "The Institution of Electrical Engineers," to which the PRESIDENT briefly responded.

REPORT OF THE POST AND TELEGRAPH DEPARTMENT OF QUEENSLAND FOR THE YEAR 1891.

THIS report, which has recently been issued, states with reference to the Telegraph Department:—

Negotiations were entered into between the Hon. Audley Coote, M.L.C., of Tasmania, representing the Société Française des Télégraphes Sous Marins, of Paris, and the Postmaster-General of Queensland, on the subject of a submarine cable from Queensland to New Caledonia, a distance of 900 miles, as the first section of the main Pacific cable to connect Queensland with Vancouver, and the following arrangement was arrived at:—

"Subject to guarantee on the one part by the French Government, and by the Australian Governments on the other part, for a period of 30 years, and for an annual sum of 300,000 francs (£12,000) as subsidy over and above the expenses of working, estimated at 60,000 francs (£2,400), but the sum to be paid for the said guarantee shall not exceed 300,000 francs (£12,000), the proceeds of the working above the 60,000 francs (£2,400) of expenses above-named shall go in reduction of the said 300,000 francs (£12,000) of annual guarantee, and without reference to one year being taken without another.

"The Government of New South Wales to guarantee the sum of 50,000 francs (£2,000), the Government of Queensland to guarantee 50,000 francs (£2,000), being together one-third of the total guarantee, the other two-thirds to be guaranteed by the French Government, and the annual reduction of the guarantee according to the receipts from the working shall be shared at the rate of one-third for the Governments of New South Wales and Queensland, and two-thirds for the Government of France.

"In consideration of the above guarantee the Government of New South Wales and the Government of Queensland shall have free use of the cable for their own Government messages, up to the extent of their guarantee in each year.

"The cable to be kept in good working order, and if it should become silent and remain so for 21 days, then the guarantee shall cease until the cable is in working order again.

"The working expenses of the cable shall not exceed in any one year the sum of £2,400, it being understood that the working expenses shall be a first charge against the receipts from messages going over the cable; all the receipts over and above the working expenses are to go towards the annual reduction of the guarantee of £12,000, to be shared at the rate of one-sixth for the Government of Queensland, one-sixth for the Government of New South Wales, and two-thirds for the Government of France.

"The minimum rate for messages of 10 words and under, including address and signature, shall be 7s. from Queensland to New Caledonia, made up as follows:—The cable to receive 6s., Queensland, 1s., and for each additional word 7d., of which the cable shall receive 6d. and Queensland 1d.

"A message of 10 words and under from New South Wales shall be 8s., divided as above, with 1s. to New South Wales for a message of 10 words, and 1d. for each additional word.

"The Company to reduce the charges directly the business warrants it.

"The above cable to form part of the main Pacific cable connecting Australia with either Vancouver or San Francisco, or such other part as may be determined.

"As soon as the main Pacific cable is laid, the guarantee above referred to shall be re-arranged, and come into and be a part of any joint purse guarantee given by the other countries or colonies joining in a guarantee for the main Pacific cable."

When the Postmaster-General for New South Wales, on behalf of his Government, had agreed to the guarantee of £2,000 per annum, the necessary agreement was entered into by the Postmaster-General of Queensland.

In a report from the Postmaster to the Honourable the Colonial Treasurer, he suggested that the locality of Burnett Heads affords all the advantages of a sheltered position, a good landing, and established telegraphic communication, and, keeping on the shallow plateau of soundings inside the 100-fathom contour as much as possible, and besides being 55 miles nearer to Noumea than Gladstone, the Queensland end of the cable would lie across Hervey's Bay, in deep water and comparatively even bottom.

The question of laying the cable to Sandy Cape or Cape Moreton was also considered, but it was decided that neither of these positions offered such advantages as the Burnett Heads.

The report of the superintendent of electric telegraphs, Mr. A. F. Matveieff, concerning the telegraph branch, states that since the last annual report, dated June 5th, 1891, the total mileage of extensions, dismantled line, &c., deducted, amounts to 115 miles of line, 156 miles of wire. There are now 9,996½ miles of line, and 17,646 miles of wire open for public business. At the close of 1891 there were 352 stations in daily operation, and 807 officers employed, including those holding appointments in other departments, but exclusive of assistants at country stations (officer's wives) and construction parties.

In the southern and south western districts the total number of interruptions on land lines was 715. Of these 170 were under an hour's duration, 134 over one and under three hours, 97 over three and under six hours, 74 over six and under 12 hours, 125 between 12 and 24 hours, and 77 between one and two days. The remaining 38 existed from two to 12 days, and, with two or three exceptions, were due to very heavy storms or large bush fires destroying long distances of line. On December 10th, a heavy thunderstorm bent 17 iron poles near Jondaryan. On May 23rd an interruption commenced between Charleville and Cunnamulla which lasted ten days, and was caused by a piece of very fine copper wire twisted on to the tie wire, then pushed under the insulator, brought round the insulator pin and fastened securely to the lightning conductor of a pole.

Unfortunately, the offenders were not discovered. In the northern district, for the 12 months ended March 31st last, there were 69 total interruptions to communication.

The expenditure for 1891 was as follows:—

Southern district	£4,027	3	8
Central „	1,221	14	1
Northern „	3,092	12	10
	£8,341	10	7

SUMMARY, TELEGRAPH SERVICE, 1891.

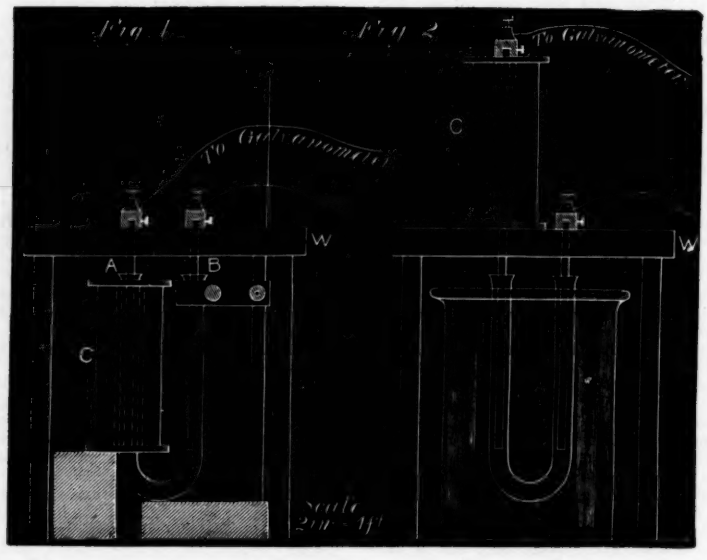
Number of telegraph stations	352
Miles of line	9,973½
Miles of wire	17,622¾
Cost of construction (including buildings) ...	£835,764 0s. 2d.
Number of messages transmitted and received (including international)	1,189,355
Revenue (excluding O.H.M.S.,* £6,581 15s. 2d.) ...	£95,146 12s. 1d.

ELECTRO-CHEMICAL EFFECTS ON MAGNETISING IRON.†

BY THOMAS ANDREWS, F.R.S.

PART I.

HAVING for many years past been engaged in researches relating to the various aspects of the corrosion and oxidation of metals, nearly two years ago it occurred to me to investigate the probable effect of magnetisation on the relative electro-chemical position of a pair of bright iron bars, one magnetised by a coil, the other unmagnetised, when thus simultaneously exposed in circuit, in a suitable apparatus, to the action of various powerful oxidising agents and saline solutions. I accordingly specially prepared numerous long polished rods of soft wrought scrap iron 0·261 inch diameter, for use in the investigation.



I was not able to commence the preliminary observations until towards the end of 1885, and, after much consideration and various trials then made, decided to adopt the following method of experimentation as perhaps calculated to yield the most delicate and accurate results; pressure of other work has, however, delayed the earlier completion of the work. The general arrangement and methods of experimentation pursued are described below, and the apparatus is delineated on fig. 1 and fig. 2.

Two pieces were adjacently cut from a long finely polished iron rod, so that the pieces might as near as practicable be of identical chemical composition and molecular constitution. After being firmly placed and adjusted as to equal length, &c., in the wooden supporting frame W, they were immersed to an exactly equal depth in the solution contained in the U-tube, which latter was also rigidly supported by a stand. In the duplex experiments made with apparatus fig. 2, the U-tube was immersed in a large volume, four pints, of cold water to ensure equal temperature conditions during experimentation for the respective solutions in each limb, the cold water being maintained in steady circulation around the tubes. The rods were connected in circuit with a sensitive galvanometer, having a resistance of 521 ohms, and of known calibration, the galvanometer being under constant telescopic observation during the experiments, and the normal galvanic action between the two bars previously observed in every experiment. Considerable care was requisite to obtain this accurately, so as not practically to interfere with the subsequent results seemingly due to magnetic influences. A removable coil, C, of stout silk-covered copper wire (No. 16 gauge) mounted on a large wooden bobbin 6 inches long, enclosed the limb, A, of the U-tube, or when using apparatus fig. 2, the coil surrounding the upper portion of the long bar requiring magnetisation. The coil used in the experiments with apparatus fig. 1 consisted of six depths or wraps of the insulated copper wire, each wrap having 81 turns, making in the whole a coil of 486 convolutions. The other coil employed in the experiments with apparatus fig. 2 was of similar construction, but had ten depths of insulated copper wire of the same thickness, constituting a coil with a total of about 750 convolutions.

A single cell bichromate battery, easily put in or out of operation, was attached to the coil, and the battery was recharged with the same strength of solution for each observation. After a suitable time had been allowed in each experiment for steady galvanic equilibrium to be established between the two iron rods, in the solution in the tubes, which took place at periods varying with the nature of the solution, the coil was put into operation. In the experiments with fig. 2 the end of the bar in the solution was the S seeking pole. It was most interesting to observe the result. The rod, A, thus magnetised in most of the solutions became the metal positive, the galvanometer indicating its steadily increasing electro-chemical positive position compared with that of the unmagnetised bar, B. Repeated careful experimentation appeared to indicate that the increased positivity of the rod, A, observed under these conditions, was due to the increased action of the acid or saline solution on the iron rod which was under magnetic influence, owing to which it became surrounded by a slightly stronger saline solution than the other unmagnetised rod, B, which was apparently less acted upon. In some cases in the more powerfully acid solutions, Table A, columns 4, 5, 7, 8, a kind of maximum point seemed to be generally reached, and after the more violent action of the acid had expended itself, a reduction of the E.M.F. between the rods was generally noticed as the solution in the B-tube gradually approached an equilibrium of composition compared with the solution in the A limb of the U-tube, and subsequently a reverse action in some cases was observed. The unmagnetised rod, B, appeared to be less rapidly acted upon than the one under magnetic influence. On magnetisation of the bar the above full effect on the galvanometer was not always of an instantaneous character, though a short time only appeared requisite for its development. The solutions employed are given in Table A, and the results therein recorded were derived from a series of constant observations, a comparison in some instances being afforded between the respective effects obtained by the two forms of apparatus employed.

It may be noticed that a fresh pair of the iron rods, cut adjacently from a long polished rod, were used for each experiment, and 123 pairs were used in course of this part of the investigation, the whole of the experiments being many times repeated to ensure accuracy, the results recorded being the average of many observations. In some instances somewhat higher results were noticed.

It is almost impossible to obtain two pieces of iron (even when forming adjacent parts of one polished rod) which, when in solution are devoid of some slight galvanic action between themselves; but the greatest care was exercised in the special preparation of the iron used, so that this variation might be reduced to a minimum.

To ensure success in the experiments it was found essential that the iron bars should possess an excellent polished surface, free from magnetic or other oxide or impurities; the solutions were also concentrated, and both discrimination and manipulative skill were requisite in obtaining the practical galvanic equilibrium of the bars at commencement. The time needed to ensure this seemed to vary considerably with different solutions according to circumstances. A sensitive galvanometer was also a requisite of success in these observations, and telescopic readings were necessary, as in some cases the effects were small.

It seems desirable here to add a few remarks on the possible influence of temperature on the reactions, and to state the means

* May to December only. † From the *Proceedings of the Royal Society.*

used in the endeavour to minimise errors from this source. In conducting the experiments, I should have preferred using greater battery power, but employed only one bichromate cell; the wire of the coil was also of considerable thickness to prevent undue heating from resistance. The centre of the wooden coil bobbin was also about ½ inch in thickness, so as to act as a central non-conductor. Moreover, an air space was allowed of ½ inch between the wooden centre of the coil and the enclosed limb of the U-tube. The other limb for the unmagnetised bar was enclosed by another coil, which, when not in use, acted as an external protective jacket. Notwithstanding these precautions, there was a slight increase of temperature in the interior of the coil, C. Thermometers inserted in test solutions, one in each limb, gave an average difference of about 1° Fahrenheit at the end of an hour, this increase of temperature in the solution in the coil tube being, however, very gradual. It would be untenable to state that this difference of temperature, arising from the action of the coil, did not to some slight extent influence the results of the experiments with apparatus fig. 1; but the results obtained therewith could certainly not be regarded as due only to differences of temperature conditions between the two tubes. Most of the experiments with that apparatus afford within themselves evident proof to the contrary; thus, it will be seen, that the magnetised bar assumed a prominent positive position almost immediately after magnetisation, in the case of nitric acid, before any perceptible difference of temperature could obtain between the respective tubes (see Table A, columns 6 and 7).

Moreover, the exceptional negative position of the magnetised bar under the same temperature conditions, in the case of sulphuric acid, affords evidence that the effect was not due to these temperature causes. To more clearly demonstrate, however, that the results were mainly due to the influence of magnetisation, and acting on the kind suggestion of Prof. G. G. Stokes, it was decided to make a duplex series of observations. I accordingly devised the modified form of apparatus fig. 2, which was intended to eliminate possible sources of error from temperature difference, by keeping the U-tube surrounded by a large volume of cold water during the experiments; the solution in the respective tubes being thus maintained under equal conditions. In comparing the results obtained with the two forms of apparatus, it should be borne in mind that, when using the apparatus, fig. 2, the cold water surrounding the U-tube would have a tendency to retard the increase of the temperature of the solutions naturally arising from chemical combination. Further, the coil in fig. 2 being at one end of the long bar would be calculated to modify the magnetisation of the other end of the metal in the solution, compared with its action in fig. 1, where the coil almost entirely surrounded the bar: hence in fig. 2, the coil was made somewhat larger to overcome this to some extent, and the end of the bar, B, was shortened in experiments with fig. 2, so that this bar would be less liable to be affected magnetically by the external influence of the larger coil. I hope that the confirmatory results obtained in the two sets of observations may be considered as fairly satisfactory.

TABLE A.

E.M.F. in volt, and electro-chemical position of magnetised bar compared with the unmagnetised bar, the positive or negative position of the former being respectively indicated by the signs + and −.

Time from commencement and duration of magnetisation in minutes.		Column 1. Potassium chlorate and one-fifth nitric acid.		Column 2. Potassium chlorate and one-third nitric acid.		Column 3. Potassium chlorate and hydrochloric acid.	
		I.	II.	I.	II.	I.	II.
hrs.	mins.						
0	0	0·000	0·000	0·000	0·000	0·000	0·000
0	1	...	+ 0·004	+ 0·014	+ 0·002	...	...
0	2	...	...	...	+ 0·003	...	...
0	2½	...	+ 0·006	+ 0·014	+ 0·004	...	+ 0·002
0	3	...	...	...	+ 0·005	...	...
0	4	...	...	+ 0·016	+ 0·006	...	...
0	5	+ 0·005	+ 0·006	+ 0·011	+ 0·007	+ 0·002	+ 0·003
0	6	...	...	...	+ 0·007	...	...
0	7	...	...	...	...	...	...
0	7½	...	+ 0·004	+ 0·011	+ 0·008	...	+ 0·006
0	8	...	...	...	...	...	...
0	9	...	...	...	...	...	...
0	10	+ 0·006	+ 0·004	+ 0·011	+ 0·008	+ 0·004	+ 0·004
0	11	...	...	...	...	...	...
0	12	...	...	...	...	...	...
0	12½	...	...	...	...	...	...
0	13	...	...	...	...	...	...
0	14	...	...	...	...	...	...
0	15	+ 0·005	+ 0·003	+ 0·010	+ 0·007	+ 0·003	+ 0·004
0	17½	...	...	...	+ 0·007	...	...
0	20	+ 0·006	+ 0·003	+ 0·010	+ 0·007	+ 0·007	+ 0·004
0	25	+ 0·006	+ 0·003	+ 0·010	+ 0·007	+ 0·008	+ 0·004
0	30	+ 0·007	+ 0·002	+ 0·010	+ 0·009	+ 0·007	+ 0·005
0	35	+ 0·007	+ 0·003	+ 0·011	+ 0·006	+ 0·009	+ 0·004
0	40	+ 0·007	+ 0·003	+ 0·011	+ 0·006	+ 0·008	+ 0·006
0	45	+ 0·008	+ 0·003	+ 0·012	+ 0·005	+ 0·007	+ 0·005
0	50	+ 0·009	+ 0·002	+ 0·011	+ 0·005	+ 0·006	+ 0·005
0	55	+ 0·008	+ 0·003	+ 0·012	+ 0·005	+ 0·007	+ 0·006
1	0	+ 0·007	+ 0·003	+ 0·013	+ 0·005	+ 0·007	+ 0·005
1	5	...	+ 0·005	...	+ 0·004	...	+ 0·009
1	15	...	...	...	+ 0·005	...	+ 0·006
1	30	...	+ 0·007	...	+ 0·006	+ 0·009	...
1	45	...	+ 0·006	...	...	+ 0·009	...
2	0	...	+ 0·005	...	+ 0·005	+ 0·011	...

TABLE A.—*continued.*

E.M.F. in volt, and electro-chemical position of magnetised bar compared with the unmagnetised bar, the positive or negative position of the former being respectively indicated by the signs + and −.

Time from commencement and duration of magnetisation in minutes.		Column 4. Potassium bi-chromate and nitric acid.	Column 5. Ferric chloride and nitric acid.		Column 6. Nitric acid, sp. gr. 1·388, one part, and three parts water.	
		II.	I.	II.	I.	II.
hrs.	mins.					
0	0	0·000	0·000	0·000	0·000	0·000
0	1	...	...	− 0·004	+ 0·026	+ 0·004
0	2	+ 0·009	...	+ 0·002	...	...
0	2½	+ 0·005	...	+ 0·002	+ 0·020	+ 0·005
0	3	+ 0·009	...	+ 0·011	+ 0·020	+ 0·007
0	4	+ 0·010	...	+ 0·013	+ 0·016	+ 0·009
0	5	+ 0·007	...	+ 0·013	+ 0·014	+ 0·009
0	6	...	...	+ 0·020	...	...
0	7	...	...	+ 0·016	...	...
0	7½	...	...	+ 0·006	+ 0·011	+ 0·011
0	8	...	...	+ 0·022	...	...
0	9	...	...	+ 0·034	...	+ 0·011
0	10	+ 0·006	...	+ 0·011	+ 0·008	+ 0·011
0	11	...	...	+ 0·014	...	...
0	12	...	...	+ 0·011	...	...
0	12½	+ 0·009	...	...	...	+ 0·010
0	13	...	...	+ 0·009	...	...
0	14	...	...	...	...	...
0	15	+ 0·004	...	+ 0·002	+ 0·009	+ 0·005
0	16	...	...	...	...	...
0	17	...	...	...	...	...
0	17½	...	...	+ 0·009	...	...
0	19	...	...	...	...	...
0	20	+ 0·007	+ 0·009	+ 0·007	+ 0·007	+ 0·005
0	22½	...	...	...	...	...
0	25	+ 0·005	+ 0·018	+ 0·004	+ 0·001	+ 0·003
0	30	+ 0·003	+ 0·038	+ 0·002	+ 0·001	+ 0·004
0	35	+ 0·001	+ 0·038	+ 0·003	+ 0·011	+ 0·004
0	40	+ 0·004	+ 0·023	+ 0·002	+ 0·012	+ 0·004
0	45	+ 0·001	+ 0·002	...	+ 0·013	+ 0·004
0	50	+ 0·002	+ 0·004	...	+ 0·009	+ 0·006
0	55	...	+ 0·005	...	+ 0·012	+ 0·007
1	0	+ 0·006	+ 0·006	+ 0·001	+ 0·013	+ 0·007
1	5	...	...	...	...	...
1	15	...	...	...	...	...
1	30	...	...	...	...	...
1	45	...	...	...	...	...
2	0	...	+ 0·007	...	...	...
2	20	...	...	...	...	...
3	0	...	...	...	...	...
3	15	...	...	...	...	...

Column 1.—The potassium chlorate was a saturated solution of the salt, to which was added one-fifth of its volume of nitric acid of sp. gr. 1·388 at 60° F.

Column 2.—The potassium chlorate was a saturated solution of the salt, to which was added one-half of its volume of nitric acid of sp. gr. 1·388.

Column 3.—The potassium chlorate was a saturated solution, to which was added an equal volume of hydrochloric acid of sp. gr. 1·16.

Column 4.—The potassium bi-chromate was a saturated solution, to which was added one-half of its volume of nitric acid of sp. gr. 1·388.

Column 5.—The ferric chloride was a saturated solution, to which was added one-half of its volume of nitric acid of sp. gr. 1·388.

General Remarks.

Potassium Chlorate and Nitric Acid Solutions, Columns 1 *and* 2.—At the termination of some of these experiments, the depth of colour of the solution surrounding the magnetised iron was perceptibly of a darker shade than the colour in the tube surrounding the unmagnetised bar, this was confirmed by Eggertz's carbon coloration test.

Ferric Chloride and Nitric Acid, Column 5.—At 40 minutes from the commencement of one experiment in apparatus fig. 1, the record was an E.M.F. of 0·023 volt, the magnetised bar being positive; the battery was then attached to a smaller coil surrounding the other bar, B, which was then magnetised instead of the bar, A, and in course of five minutes a reduction in the positive position of bar, A, to an extent of 0·021 volt occurred. At forty-five minutes the battery was reconnected to the coil surrounding the bar, A, producing a steady increase of positive position in that bar as recorded in Table A, column 5.

Aqua Regia, undiluted.—With this reagent in fig. 1 no very decided galvanic reaction took place until the bar had remained magnetised for some ten minutes, when violent effervescence occurred accompanied by evolution of dense reddish-brown fumes, the magnetised bar then becoming rapidly electropositive to an extent yielding an E.M.F. of about 0·110 volt. This position was subsequently more or less maintained for some ten minutes, the galvanometer, however, gradually falling to zero as the ebullition in both tubes subsided. This was a difficult experiment to make, owing to the very violent effervescence.

Aqua Regia, diluted, Column 8.—Up to the commencement of the effervescence no perceptible difference in the colour of the solution in the respective limbs of the U-tube was noticed; but immediately

TABLE A.—*continued.*

E.M.F. in volt, and electro-chemical position of magnetised bar compared with the unmagnetised bar, the positive or negative position of the former being respectively indicated by the signs + and —.

Time from commencement and duration of magnetisation in minutes.'		Column 7.		Column 8.	Column 9.	Column 10.	
		Nitric acid, sp. gr. 1·388, 1 part, and 4 parts water.		Aqua regia, 2 parts HNO_3 and 1 part HCl, diluted to one-half with water.	Hydrochloric acid, sp. gr. 1·16, diluted to one-half with water.	Sulphuric acid (concentrated), sp. gr. 1·84.	
		I.	II.	II.	II.	I.	II.
hrs.	mins.						
0	0	0·000	0·000	0·000	0·000	0·000	0·000
0	1	...	+ 0·004	+ 0·002	...	...	...
0	2½	...	+ 0·006	...	...	...	—0·001
0	3	...	+ 0·009	...	...	...	...
0	4	...	+ 0·012	...	...	...	...
0	5	+ 0·012	+ 0·011	+ 0·004	—0·0004	—0·003	—0·002
0	6	...	+ 0·010	...	...	...	...
0	7½	...	+ 0·007	+ 0·006	...	...	...
0	9	...	...	...	...	...	...
0	10	+ 0·011	+ 0·003	+ 0·011	— 0·001	—0·004	—0·003
0	11	...	+ 0·005	...	...	...	...
0	12	...	+ 0·005	+ 0·013	...	...	...
0	12½	...	...	...	...	...	...
0	13	...	+ 0·005	...	...	...	...
0	14	...	+ 0·003	+ 0·014	...	...	...
0	15	+ 0·013	+ 0·001	+ 0·027	— 0·001	—0·005	—0·005
0	16	...	...	+ 0·027	...	...	...
0	17	...	...	+ 0·014	...	...	...
0	19	...	...	...	...	...	...
0	20	+ 0·014	+ 0·004	+ 0·025	— 0·001	—0·006	—0·005
0	22½	...	...	+ 0·010	— 0·001	...	...
0	25	+ 0·013	+ 0·004	...	— 0·001	—0·005	—0·006
0	30	+ 0·012	+ 0·005	+ 0·004	— 0·001	—0·007	—0·006
0	35	+ 0·013	+ 0·005	...	— 0·001	—0·008	—0·006
0	40	+ 0·012	+ 0·004	...	— 0·001	—0·009	—0·006
0	45	+ 0·012	+ 0·003	+ 0·001	— 0·001	—0·011	—0·005
0	50	+ 0·012	+ 0·003	...	— 0·001	—0·012	—0·005
0	55	+ 0·012	+ 0·004	+ 0·001	— 0·002	—0·014	—0·006
1	0	+ 0·011	+ 0·004	+ 0·001	— 0·002	—0·016	—0·006
1	15	...	...	...	— 0·003	—0·022	—0·007
1	30	...	...	...	— 0·002	—0·022	—0·008
1	45	...	...	...	— 0·004	...	—0·008
2	0	...	...	...	— 0·004	...	—0·009
2	20	...	...	...	...	...	—0·028
3	0	...	...	...	...	...	—0·009
3	15	...	...	...	...	...	—0·021

The records in the above table under divisions I., were experiments made with apparatus, fig. 1, the records entered under divisions II., relate to observations made with apparatus, fig. 2.

The records of the effects in the stronger solutions do not indicate the full extent of the electric action compared with that of the weaker solutions; because in the former case the tubes could only be partially filled, so as to prevent boiling over.

on the violent ebullition occurring, which took place generally about ten minutes from commencement, the solution surrounding the magnetised bar frequently became of a very much darker tint. This marked difference between the colour of the respective solutions in the two tubes was maintained for some time, afterwards the two solutions became apparently nearly chromatically equal. The electrochemical effect appeared to be less marked when using aqua regia containing excess of H Cl. The relative electrochemical position of the two bars in such case being less divergent, the H Cl appearing to act somewhat as a strong diluent.

Hydrochloric Acid and Sulphuric Acid, Columns 9 and 10.—Singular to say, the previously described magnetochemical effects were comparatively small when using such a powerful reagent as hydrochloric acid alone, either concentrated (sp. gr. 1·16) or diluted. When this acid was employed in conjunction with concentrated solution of potassium chlorate (Table A, column 3), the effects there recorded appeared due rather to the oxidising agency of the evolved chloric compounds; in the presence of magnetism, the reactions with this electrolyte were occasionally irregular, the excess of H Cl appearing sometimes to interfere. Sulphuric acid, conc., also seemed to behave abnormally, though this acid does not ordinarily act strongly on iron. The experiments with both the above acids in course of a large number of observations, proved exceptions to the general rule. The magnetised bar in the sulphuric acid, conc., and also in the hydrochloric acid, diluted, became the electronegative metal, not only in the case of H_2SO_4, when using the apparatus fig. 1, but also when experimenting with the modified form, fig. 2. Occasionally, with sulphuric acid, conc., the magnetised bar was, on first magnetising it, slightly electropositive for a few minutes only; but afterwards became steadily negative.

Under the conditions of experimentation, the magnetised bars in the powerful oxidising reagents used almost invariably assumed the electropositive position, the presence of $H NO_3$ appearing essential to the full development of the positive position of the bar under the influence of magnetism. On the contrary, the magnetised bar seemed to be the electronegative metal in H_2SO_4, conc., and also in the H Cl (diluted) as electrolytes. The two latter reagents by their action on the metal generate gases of a reducing character. These exceptions are not, however, averse to the principle that magnetisation exerts an influence on the relative electrochemical position of a pair of iron bars, varying according to the nature of the solution and the extent to which one of them is magnetised. In the above exceptions, it is possible that the magnetised bar assumed the negative position consequent on its being the one more attacked, under magnetic influences, by the reagent; thus producing a greater evolution of reducing gases in the tube, A, containing the magnetised bar than in the other tube; this may perhaps explain the negative effect. The observations of this memoir therefore indicate that, under the powerful and rapidly oxidising conditions described, a magnetised bar becomes metal positive to an unmagnetised one, whereas in the exceptional instances above alluded to, the electronegative effect occurs, possibly owing to the presence in the solution of such reducing agent as nascent hydrogen, &c.

In the present incomplete stage of the enquiry these remarks are only offered tentatively.

The effects could not be expected to be large; I anticipate, however, generally more marked results in a more powerful magnetic field, exerting its influence, perhaps, for longer periods; but I think the experiments now submitted appear sufficient at least to afford an indication that, under the conditions recorded, magnetisation exerts on iron, in some solutions, an appreciable effect. The results already obtained in this direction are so far interesting as to encourage further research into the nature of this novel and subtle phenomenon.

APPLICATIONS TO BE MADE TO PARLIAMENT FOR VARIOUS POWERS.

THE following announcements were made in last Tuesday's *London Gazette*:—

Application to Parliament, 1893 Session, by the Postmaster-General for powers to extend the Telegraph Instrument Factory, Bovay Place, Holloway.

Application to Parliament, 1893 Session, for a Bill, authorising the construction of an underground railway from Clapham Junction to Paddington and other incidental powers. Motive power to be employed is cable or electricity.

Application to Parliament, 1893 Session, by the Goole & District Gas and Water Company, for various powers, among which are powers as to the supply of electricity.

Application to Parliament, 1893 Session, by the London County Council for general powers, including the following: "To confer on the Council all necessary powers to enable them to provide and maintain an electric lighting installation on the Victoria Embankment and the gardens thereon, and on the Westminster and Waterloo Bridges and neighbouring places, and for that purpose to empower the Council to generate and store electricity, and to use any lands for the time being belonging to them, and upon such lands to erect and maintain any necessary workshops, engine houses, storehouses (including places for storing electricity), or other buildings, and to manufacture, buy or hire any machinery, steam engines, gas engines, or other apparatus, and to take, hold, and use patent rights, or licenses, or authorities under letters patent for the use of inventions relative to the generation, utilisation, distribution, or supply of, electricity or other lighting agent."

LEGAL.

THE THREE-WIRE SYSTEM.

DR. JOHN HOPKINSON *v.* THE ST. JAMES'S AND PALL MALL ELECTRIC LIGHT COMPANY, LIMITED.

(*Continued from page* 618.)

SIXTH DAY—NOVEMBER 22ND.

THE hearing of this action was resumed before Mr. Justice Romer in the Chancery Division of the High Court of Justice, the plaintiffs having completed their inquiries in connection with the alleged anticipation of Dr. Hopkinson's patent by the National Electrical Company, at Glasgow.

Sir RICHARD WEBSTER, Q.C., said that the necessary inquiries had been made, and he was in a position to cross-examine Mr. Andrews.

Mr. J. D. F. ANDREWS entered the witness-box, and was cross-examined by Sir Richard Webster as follows:

When were you first asked anything about this supposed three-wire anticipation?—I should say about four weeks ago.

By whom?—By a gentleman from Messrs. Siemens Bros.

What is his name?—I do not know. I do not see him in Court.

I understand you to say you drew this diagram on the previous Saturday afternoon. Were you alone?—Quite alone.

Had you any preliminary sketch?—I drew one myself, but it is not here.

You are a patentee of an improvement?—I am.

You had taken out a specification of July, 1890, for an improved three-wire conductor?—Yes.

Between that conversation and the time of your leaving Glasgow, had you ever drawn or described the wiring to anybody?—I don't think so.

You had a great deal to do with three-wiring in other places?—Yes.

Was there a gas engine?—To the best of my recollection it was 8 horse-power.

Will you undertake to say it was not 2 horse nominal, working up to 3½?—I will not undertake to say that.

To do the work you have described in that diagram would not 6 or 8 horse-power be required?—You must understand although I have put lamps, they were not all on. If all the lamps were on which I have shown, I dare say more than 2½ horse-power would be required. There were never more than 20 on in the shop.

The workmen's benches were lit by gas?—Yes.

Did you ever complete an electric glow lamp there fit for sale?—I cannot say we did.

Were you the patentee or the inventor of an improved arc lamp?—Yes, the plate lamp. I experimented with that there on this particular machine.

Were not part of your experiments to try and run your plate lamps in series?—Yes; but not on that machine.

Do I understand you to say that you always knew you had used this three-wire system publicly in Glasgow?—Yes, so far as that workshop goes.

Invalidating the three-wire system, no matter whose it was?—I never thought of invalidating this patent.

You knew perfectly well that the three-wire was supposed, rightly or wrongly, to be the subject of a patent for many years?—Yes.

Did you yourself apply to Dr. Hopkinson for a license under this patent for the three-wire system?—Yes.

Do you represent that then you knew there had been a public user of it?—I did.

Did you endeavour to get the best terms you could to be sole licensee of Dr. Hopkinson's patent?—Of a certain application of it.

Did you see Mr. Bellfield, Mr. Skanes, and Mr. Baldwin?—Yes.

Was your patent for putting the three conductors round one another with insulating material in between?—Yes.

You advertised your improved conductor for the purpose of three wires?—I announced it publicly.

Did you say to those gentlemen that unless you could get a license under Dr. Hopkinson's patent, your patent would be worth nothing?—Very likely I did.

At your interview with these gentlemen, did you make the slightest suggestion that Dr. Hopkinson's patent was invalid?—I did. I undertake to say that I gave them certain instances where the three wires had been used. I mentioned Blackpool, but no other instance that I can remember.

Did you say a word about Glasgow?—No.

You used that in order to get better terms?—No. We were having a pleasant conversation. I had several interviews with these gentlemen.

Did you not, on more than one occasion, tell them that unless you could get a license you could not work your patent?—I think I did mention it to them, but not on more than one occasion.

Was there a Mr. Graham connected with you?—Yes; he was managing director of the company I was servant in.

Was there a Mr. Muir?—Yes; he was practically the director.

Did you know Mr. Bottomley?—Yes; he was one of Lord Kelvin's confidential assistants.

Did you know Lord Kelvin?—Yes.

Did he come to see the place?—Yes.

Were you anxious to get Lord Kelvin to assist you in bringing out a company?—I have no recollection of it.

Did you apply to Mr. Bottomley to ask Lord Kelvin to be connected with the new company you were bringing out?—I have no recollection of that. I will undertake to say I did not.

Did you see Mr. Rankin Kennedy there?—He was connected with the company, but not with the workshop particularly. I did not try to get these gentlemen to assist in the promotion of the National Electric Company, Limited.

Were you connected with any company at this time?—Only as a servant with the National Electric Company, Limited.

Did any of those gentlemen come and inspect the workshop?—Yes.

Were they shown everything there was there?—Everything they cared to look at.

Was Mr. Rankin Kennedy there in the early part of 1882?—I never recollect seeing him there.

Do you know whether Mr. Kennedy ultimately purchased the plant in that place?—I never knew such a thing.

Do you know what became of the dynamo?—I believe I afterwards bought it in 1883.

Will you pledge your oath that Mr. Kennedy did not buy that dynamo?—No.

Did not Mr. Kennedy, in 1883 or 1884, actually set up the three-wire system, and work it in Woodside, Glasgow, close to where you were?—I have no recollection. I would not swear he did not.

Are there any people here who saw the wire as you described it on the last occasion?—Yes; Mr. McKillock, Mr. Forest, and Mr. Town.

Did you never notice at that time a great deal of interest was taken by the men in the room that the experiments were going on in?—They took great interest in the particular articles they were making.

Did you ever notice men put bradawls or wires across the two metals, with the result that the lamps upon one side of the middle wire increased in brilliancy?—I do not know except from what I have been told since. Mr. Town told me.

Have you any doubt that happened?—No. I do not doubt his word at all.

If it is true that the result of putting a bradawl across from an outside wire was to send the lamps on one side up in brightness, you know that could not have been the three-wire system?—No; but I do not believe they did go up in brightness. If the lamps increased in brightness, that would show that it was not the three-wire system.

Did Mr. Town tell you that the lamps went out?—I was told they went out.

Was there any difference in the size of the wires you used?—No.

Did you not show to Mr. Rankin Kennedy what was being experimented upon in that shop?—I never showed Mr. Rankin Kennedy anything. I never saw him there. I have been told he was there, and I believe it.

Did you show the things to Sir Wm. Thomson (now Lord Kelvin)?—Yes.

Do you suggest that you are now conscious that you had discovered a new and important system of wiring in what you did in that shop?—I did not discover it, but I was well acquainted with this particular wiring—I had used it at Siemens Bros. before.

The three-wire system?—Yes.

You mean that what you used at Siemens Bros. was a common return?—But in the case of alternating current machines, it was virtually the three-wire system as we know it now.

Is it not the fact that what you had been dealing with was a common return for two currents of like polarity?—We were aware that the dynamos were in series, and that it was not a common return, though we gave it that name.

Were not the poles on the outer side of like polarity?—No, they were not.

Were the wires of equal size?—In the case of Blackpool they were. As a rule the return wire was not larger than the other, only when we added other circuits.

In the common returns used at Messrs. Siemens, was it not the invariable practice, up to 1882, to use a common return of double or much larger diameter?—No.

Was the middle ring in the Siemens machine of double diameter?—I am not sure that it was in the smaller machines, but it was in the larger ones.

Was not that for accommodating a larger volume of current?—Yes; but that was on account of there being other circuits to convey back to it than the two.

The dynamo you got from Siemens can be identified by the number?—I have sent a gentleman to see the number of that machine. It is at Greenock.

In re-examination by Mr. FINLAY, Q.C., WITNESS said that he never had any idea of contesting the validity of Dr. Hopkinson's patent; on the contrary, he intended to uphold it if it could be upheld. The conversation he had about prior user was a general and chatty conversation, in the course of which, to the best of his recollection, he mentioned that he had a common conductor, or third wire, introduced at Blackpool. He connected the third wire himself. At that time he attached no importance to the return. The use of the third wire at Siemens's acted as a safeguard in the event of one arc lamp going out; it did not act only as a common return.

Mr. WILLIAM P. MUIR, one of the directors of the National Electric Company, Glasgow, examined by Mr. FINLAY, Q.C., said he was at the works of the company in Sauchiehall Lane in 1882 almost every day. He recollected the installation with the dynamo from Messrs. Siemens. The user of that dynamo and installation was in no way secret. Anyone the directors, superintendent, or electricians liked to bring in had access to the premises, which were closed just the same as any other public works to the general public. Everything was seen by the ordinary workmen in the shop. Other people besides the workmen went there. He conducted several personal friends of his own over the works. He was not himself an electrician, and knew nothing about the number of wires.

The witness was not cross-examined.

Mr. GEORGE FOREST, examined by Mr. FINLAY, Q.C., said that he was an electrical instrument maker in the employ of Messrs. Siemens. In 1882 he was the foreman of the National Electric Company's works, Glasgow. He remembered the alternator referred to by Mr. Andrews being put up early in March. The machine arrived with three terminals, and at that time he did not know the use of the middle terminal. To the best of his belief the dynamo was connected with three wires. There was no difficulty in getting into the works; Mr. Muir was constantly sending people round. Persons having business at the office would pass through the workshop to get there, and would return the same way. A good many people came to the office. There was nothing to prevent people passing through the workshop seeing what was going on. In May, 1882, he went to the Crystal Palace Exhibition, but did not think Mr. Rankin Kennedy had been there prior to that date. He returned from the Exhibition in June, after which Mr. Kennedy was at the workshop pretty often.

Cross-examined by Sir RICHARD WEBSTER, Q.C.: The extent of his evidence about the wire was his impression that a common return was used from both. People coming in could see the wires.

And they would gain a great deal of information from those wires?—I do not think so. (Laughter.)

Cross-examination continued: From March to May, 1882, there were experiments with the Andrews arc lamp. Rankin Kennedy's arc lamp was exhibited at the Crystal Palace. Experiments were probably made with it before May, 1882, but not in their workshop. He did not think Mr. Rankin Kennedy came to the workshop in May, 1882, but he remembered the visit of Mr. Bottomley and Sir William Thomson. Those gentlemen were simply walked up to the end of

the shop where the plate lamp was, and walked back again. The dynamo having been supplied in March, it was very likely that an effective light was not obtained until August. It might have been in the autumn or winter that the Maxim lights were used. The first thing which the dynamo was put to do was to try and make some Akester lamps, and to experiment upon the plate arc lamp of Mr. Andrews. He remembered the short-circuiting of one side of the machine when Mr. Andrews was experimenting with his plate lamps. This was caused by the workmen "larking."

Mr. JAMES MCKILLOCH, who was employed as tool-maker and engineer at the Sauchiehall Lane factory, said he went there in the beginning of March, 1882, and left in November of the same year. His special work was to look after the engine and machines. He observed that there were three wires, and that one went from the dynamo to the other end of the workshop. He had prepared a sketch from recollection. Between March and July they were manufacturing some instruments for the National Telephone Company. The dynamo was used for lighting the workshop with Maxim lamps, which were put up between the beginning of March and May 5th. He left Glasgow for the Crystal Palace Exhibition on May 5th, and the Maxim lamps were up before he left. He could not say how the wires were connected with the dynamo.

Cross-examined by Sir RICHARD WEBSTER: He was now an engineer fitter in ordinary engine work. He had had no electrical experience. He remembered a workman putting a bradawl across the wires and the lamps went out; they did not get brighter.

MR. CHARLES HUNTLEY TOWN, now employed as a wireman by a firm of electrical engineers at Glasgow, said that in 1882 he was in the employment of the National Electric Company from February until the end of the year as an instrument maker. He knew that there were three wires coming from the dynamo along the side of the shop to the end of the shop, but he could not say how any of them were connected. Maxim incandescent lamps were put up between March and May. Witness assisted in putting the wires round the benches.

Cross-examined by Sir RICHARD WEBSTER: Up to the middle of the year 1882, whatever light there was was experimental, was it not?—No.

Is that your signature—"Chas. Huntley Town"?—Yes.

"The place" [reading the document] "was a private workshop two flights up a back staircase"—is that true?—As far as I can remember.

"Nobody came about the place except those who had to do with the business"—is that true?—Yes.

"Although there were a few incandescent lamps about the place from time to time, experimentally, the place was never lit for working by incandescent lamps." Is that true?—I cannot say that it is true.

Did not you dictate that to Mr. Owen, who took it down?—I remember saying something to that effect.

"Gas was the real light we worked by." Do you remember saying that?—It is true up to a certain time.

Up to what time?—Up to November.

"I have some recollection of three wires roughly passed along the wall, but do not remember how far they went. I remember some rough wires hanging overhead. I remember on one occasion a man putting a bradawl to the wires, and all the lights that were on going ou"——

[At this juncture the witness staggered and fell heavily to the ground, in a faint. Prompt assistance was rendered by the usher and by gentlemen near the witness-box. On the witness recovering consciousness, his Lordship considerately directed that he should be provided with a seat.]

Cross-examination continued: "I never examined the dynamo or the wires leading back to it"?—WITNESS said he did not remember at that time. So far as he could remember Mr. Andrews never had anything to do with the incandescent lamps.

When you made that statement to Mr. Owen, he asked you to tell him all you knew about the workshop at Sauchiehall Lane?—Yes.

Did not you say that to him, and did not he put it down from your dictation?—Yes.

Did you read it over and say that it was correct, and sign it?—Yes.

Mr. FINLAY did not re-examine. He said that was the end of the Andrews part of the case.

Prof. SILVANUS PHILLIPS THOMPSON, who, being a Quaker, was allowed to affirm, examined by Mr. Wallace, said that he had read the specification of Dr. Hopkinson. At that date he was conversant with what was going on in the electrical world. In 1882 it was known that incandescent lamps could be made and worked for many hours without breaking down, and that they could be run either in parallel or in simple series, or in various combinations of series and parallel. It was known that incandescent lamps might be arranged in a simple series, but in that case, if any one of the lamps broke down the current was broken through the whole set, and all in that row would go out. It was also known that incandescent lamps might be arranged in simple parallel, each lamp by itself forming a bridge from the positive to the negative pole, and in that case the breaking down of any one lamp did not put the others out, but it might affect their brilliancy. That was a question of the condition of supply. If the current were supplied of unvarying strength from a constant current dynamo, then the current that came in quantity enough, say, for 10 lamps, would be too much for nine. If, however, the condition of supply was not that of unvarying current, but was a condition of unvarying pressure or voltage, the lamps would be independent of one another. Further, it was well known (and used) that instead of employing lamps in simple parallel, bridges might be made of more than one lamp, such bridges being still in parallel. For example, in the Paris Exhibition of 1881 the Edison lamps were arranged always two in series, that was to say, each bridge consisted of two lamps in series, and each bridge was independent of every other bridge, so that the turning off of any bridge did not affect the other bridges. The lamps were, therefore, arranged to be turned out in pairs. Also it was well known that lamps might be arranged in three, as was the case in the Savoy Theatre. The taking back of the third wire to the dynamo was introduced. It was also known that when you arranged lamps so that there were more than one in each bridge—for example, when there were two in each bridge—you might connect by an intermediate wire the middle point of each bridge. That was used at the Paris Exhibition. The novelty was in the bringing of the third wire, which had been used as an intermediate wire, back to an intermediate point between the two mains of the generating machine. This, in itself, was no saving of copper; it was an additional expense: the saving of copper came in in the use of high voltage, which had been done before. The great advantage of the third wire was that though you had this additional expense of copper in bringing that wire back to the dynamo, you could turn out the lamps one by one instead of two by two. "Distribution" at the date of the plantiff's patent had no special meaning; it was used by electricians in its ordinary application. [In support of this view witness gave, as examples, which could easily be multiplied, extracts from his own lecture at the Crystal Palace, from a French publication, &c.] In the Inchicore installation, he said there were three or four distinct advantages. In the first place you could use three wires instead of four, which was obviously a saving of copper. Again, you saved energy by that third or intermediate wire in consequence of the circumstance that the dynamos as soon as they were used set themselves to work in series, with the result that the current down the middle wire was a mere nothing or extremely small. Besides that there was the advantage that you could use lamps with this particular machine which otherwise could not be used, and you could use with such a system machines which otherwise could not be used for the running of the lamps. In 1882 the great majority of arc lamps that had been made had been made for single running, but there had been lamps also made expressly for the purpose of running in parallel with one another, and there were lamps made expressly for the purpose of running in series with one another. At the Paris Exhibition of 1881 the steadiest lamps of all arc lamps were those of Gülcher, which were run in parallel. Others by M. Gravier worked in parallel. He knew that the Gülcher lamps were used at Battersea, and in 1882 he made a test of Gülcher lamps that were running at a Wolverhampton factory. The third wire was of use when lamps were run in series. For example, when one of the lamps was receiving from the generating machine too much current, the excess of that current would go down the third wire instead of to the second lamp. In 1881—before the date of the plaintiff's patent—it was known that dynamos could be put in series for the express purpose of getting high voltage so as to save copper. As used at the Crystal Palace, the third wire enabled Mr. Crompton to use two lamps in series where otherwise he could only have used one. There was a difference in principle between the Inchicore installation and the user by Mr. Crompton, the main difference being that at Inchicore the lamps were arranged so that there were five in series in each bridge, and there were four or five separate bridges which could be connected by means of a switchboard, which enabled the current to be sent through one bridge of five, a second bridge, and a third bridge. The advantage of the use of the third wire was that it would receive the difference between the current in the two extreme wires, if any. In his opinion there was no difference between the diagram produced by Mr. Andrews and the diagram shown by Dr. Hopkinson in his patent, saving that Dr. Hopkinson showed specifically two separate dynamos united in series, and the diagram produced by Mr. Andrews only with two sets of coils was shown. The plaintiff's specification was defective in the instructions he gave to the workman, because there were no directions about rigid coupling, the effect of which would be that the workman would have to make experiments and bring to bear subsequently obtained knowledge.

Mr. JUSTICE ROMER (to Mr. Wallace): Witness will be cross-examined on the restriction of the specification to the parallel system. Cannot you take him through the passages which have been indicated by the other side as showing that the specification is limited.

Mr. WALLACE said he thought that was a question of construction.

Mr. JUSTICE ROMER said the evidence of experts was against the defendants as to what the specification indicated.

Mr. WALLACE expressed his willingness that his Lordship should put a few questions.

Mr. JUSTICE ROMER: Look at the words "a system of conductors for an electrical supply at a fixed potential." Does that phrase aim at one where the parallel system alone is used?

WITNESS: No, certainly not. It includes all cases, whether of simple parallel or of parallels with series in them—all cases where the supply is a fixed number of volts.

Mr. JUSTICE ROMER: Have you read the specification?

WITNESS: Very carefully.

Mr. JUSTICE ROMER: Speaking as an electrician, are there any electrical expressions in it which point solely to a system of parallel lighting?

WITNESS: No.

Cross-examined by Sir RICHARD WEBSTER, Q.C., WITNESS said that Dr. Hopkinson's first exhibit was an instance of simple multiple parallel. In so far as it was fixed potential the system must be in parallel. In other words, "fixed potential at various points of the main" meant the potential which was desired at the entering side of the bridge.

Will you draw me a system of conductors for an electric supply at various points of the main at a fixed potential which is not on the parallel system?

WITNESS drew a diagram, which he handed to his Lordship, saying that that was the only possible system which would come within Sir Richard Webster's category. This diagram showed a single circuit.

Sir RICHARD WEBSTER: The moment you put other bridges across you must have a fixed potential at other points?—The moment you put other bridges across you have a system of parallel.

That is a single circuit and no main?—It is a single circuit.

Such as is now put up to light a ship with arc lights or a street?—Yes.

In this case there will be fixed current as well as fixed potential?—Yes.

You cannot make a number of bridges upon the parallel system without having fixed potential?—They would not work well.

Will you, as an electrician in the year 1882, tell me any passage in this specification which would lead a workman to apply the three-wire system in series only?—In series only there is nothing whatever.

The indicator is only useful in a system of constant potential and varying current?—The regulator is distinctly for that purpose.

That would be multiple parallel bridge?—It would be parallel, but whether it would be multiple, I cannot say.

Does it not follow that the use of the indicator shows he was referring to a system in which there was to be a fixed potential at a number of points?—Yes.

Does not that involve not only parallel bridge but multiple parallel bridge?—It involves the use of parallel bridges, but it does not say whether there shall be one, two or five lamps in each bridge.

Do you mean to suggest that Dr. Hopkinson meant to exclude that case?—I do not think he meant to exclude a series of lamps being used as bridges.

At this stage the Court rose for the day.

PROF. ALEXANDER KENNEDY, examined by Mr. WALLACE, said he was F.R.S., member of the Institute of Civil Engineers, Vice-President of the Institute of Mechanical Engineers, and had had considerable experience in electrical work. Bringing the third wire back, enabled the capacity of the system of lamps to be varied to a large or small extent without detriment to the lamps concerned. Exactly the same weight of copper could and would be used in a system in which the middle wire was not brought back, but the lamps would be liable to destruction, and the light would not be uniform.

Do you find in the specification any limitation to incandescent lamps?—No; the specification is clear on that point; it says, "Lamps or other appliances consuming electricity," so that if the lamp meant an incandescent lamp, certainly an arc lamp is another appliance.

In this specification do you find directions to use lamps in series?—A certain amount of series is an essential condition of a three-wire system.

In your opinion does the wording of that specification confine Dr. Hopkinson's system to the use of lamps in parallel?—No.

What difference do you find between the advantages derived by the installation at the Alexandra Palace and the advantages arising from such a system as described by Dr. Hopkinson?—I do not see any essential difference.

Mr. JUSTICE ROMER: Specify the advantages of the plaintiff's system as applied to multiple parallel.

WITNESS: In the first place, a larger pressure can be used in the mains than the lamps require, and, therefore, the copper in the mains can be saved; and, secondly, it is possible to turn off a large or a small portion of the load without any injury or detriment to the working of the system, the balancing current passing up or down the middle wire.

Sir RICHARD WEBSTER: Without straining the lamps or diminishing the light?—Yes.

Mr. WALLACE: At the Alexandra Palace?—There, as I understand the evidence, the lamps were such as could not have been used without a middle wire, that is to say, the only other way of using them with this three-wire system was using them on a common return system, which is, practically, a double two-wire system. As compared with that, the system had all the advantage in saving copper that would be possessed by a much more extended system. As I understand the construction of those lamps, there must have been a small or a very short current passing up or down that middle wire somewhat frequently during their working, because one lamp might have its arc entirely broken, and then the other lamp would have to be fed for an instant or two through the middle wire.

If Mr. Crompton had added a greater number of lamps they would have been in parallel?—He might have added a greater number of lamps in parallel.

Was there anything at that time to prevent him doing it?—I do not know of anything.

At that time, would it have required any invention to put up 4, 6, 8, or 10 lamps instead of two?—I do not think so. There were lamps that ran in parallel in 1882.

There was no cross-examination.

Mr. WM. MORRIS MORDEY, member of the Council of Electrical Engineers, and electrician to the Brush Electrical Company, said he had had 22 years' experience of electrical working. With regard to the Inchicore installation, he thought he should have used a smaller middle wire. He heard Mr. Bellfield say that the three-wire system could not be worked on a single alternator. In witness's experience it could be worked with many advantages in that way. The three-wire system could be advantageously applied to arc lighting. He could have worked the three-wire system on a single alternating current machine, but he did not know that he should have been able, from anything in the specification, to work two machines on the three-wire system with alternating currents. In working two alternating machines, it was essential that the machines should keep in step. On other points the witness agreed generally with the other witnesses for defendant, adding that Dr. Hopkinson's regulator was of no practical use, and that he (witness) had invented one which met, successfully met, the requirements of the electrician.

Cross-examined by Mr. MOULTON, Q.C., WITNESS said that if two alternating current machines were coupled so that one could not lag relatively to the other, and started right, that was sufficient.

This closed the evidence for the defence.

Mr. JUSTICE ROMER said the best course would be to call the rebutting evidence.

Dr. HOPKINSON, re-called, was handed a model of his regulator put in by the plaintiffs. He said that it was made in accordance with his specification, that it was put up at the laboratory of the Westinghouse Company, and that it worked accurately on Saturday. The model produced by Mr. Swinburne was obviously different from his. The difference was material. The difference was that in the case of Mr. Swinburne's instrument the thick coil overlays the thin coil closely, whereas in his specification the thick coil was drawn at the back of the thin coil, and end to end to it. That was important, because the defect which had been alleged depended upon the mutual induction of the two currents. The thin coil induced currents in the thick coil, and if those currents exceeded a certain amount the effect might spoil the working of the instrument. The arrangement of coils in Mr. Swinburne's model was such as to induce the mutual induction of those two circuits. He had no doubt that the mutual induction was more injurious than the self-induced.

In cross-examination, witness said he did not say anything in the specification about the winding of the coils, but he showed a method which would work, and work successfully.

Mr. RANKIN KENNEDY, examined by Sir RICHARD WEBSTER, Q.C., said that he had no interest in this case, and had nothing to do with it until he was asked what he knew about the Sauchiehall Lane works. His profession had been that of an electrical engineer since 1880. As early as 1881 he was taking out patents in connection with generators and dynamos. Since then he had made, perhaps, twenty improvements, and taken out patents. As regarded the dates in this case, he had refreshed his memory by means of letters. In October, 1881, he was residing at Paisley, near Glasgow. He had then taken out his patent for an improved dynamo. He became acquainted with Mr. Graham, who was an electrical engineer in Sauchiehall Lane, Glasgow, and entered into an agreement with him for the sale of his (witness's) patent. The work in connection with the development and manufacture of his new improved dynamo was carried out in a suburb of Glasgow. He first went to the Sauchiehall workshop about the beginning of December, 1881. His visits occurred once or twice a week. He saw Mr. Akester, who was endeavouring to make incandescent lamps, and understood that Mr. Graham had that gentleman's patent. When at Sauchiehall Lane he always saw Mr. Graham, and he became acquainted with Mr Forest early in February, 1882. He first saw Mr. Andrews about the end of January, 1882. At or about December witness had a dispute with Mr. Graham, and for a time witness and Mr. Akester left him. The quarrel was made up about the beginning of February, 1882, at Mr. Graham's house. Witness was then at work on his new arc lamp, which was to be manufactured at Sauchiehall, and which he subsequently patented. In 1881, the Fine Art Gallery, Glasgow, was lighted with Maxim incandescent lamps, and, in connection with that, witness made the acquaintance of Mr. Bottomley.

Have you an intimate recollection of all that went on in that workshop, and the wiring, and everything about it?—Yes.

What engine was it?—Two-horse-power Otto, which worked up to very little over 2 H.P. I had the engine subsequently, and worked it for some time. I saw the engine taken to pieces.

Did you know from Mr. Andrews what he was working at?—Plate lamps, requiring an alternating current. I seldom saw the experiments; they were made in the evening.

Did you notice any wiring?—Yes; the wiring was put up before we had the quarrel with Mr. Graham—some of it.

What was put up?—My impression is there were three wires put up from a dynamo below the workshop; that is a Gramme.

The Gramme continued there until the Siemens came?—Yes; and afterwards.

Subsequently you knew a good deal about that wire?—Yes.

Where did the three wires run to—were there any switches?—Yes; two close to where the alternating dynamo was fixed.

Were they up before the quarrel?—I don't know.

Can you tell me whether all the three wires were connected with the Siemens dynamo, or any one of them, or any two of them?—Two of them were connected with the Siemens dynamo.

Did the third go back to the dynamo?—No.

Were you acquainted with compound parallel working?—Yes; that is shown in my specification of 1881.

Were you to put it up at the Fine Art Gallery?—Yes.

Do you know whether in compound multiple parallel, the third wire goes back to the dynamo or not?—Yes.

Does it, or does it not?—It does not.

Who helped in carrying out the experiments in connection with the Akester lamps?—Aitcheson and Andrews.

When the Siemens machine first came, how was the shop lit?—By gas. There were, however, a few electric lamps hung up by the workmen themselves. These lamps came from the Fine Art Gallery, where I had used the same lamps.

There was no permanent installation to light the workshop with electricity?—No, never at any time. All the lighting was by gas, though sometimes a Maxim lamp was hung up temporarily and light came from that. Mr. Graham, Mr. Forest, Mr. Andrews, Mr. McKilloch, Mr. Muir, Mr. Town, and Mr. McFarlane knew all about the workshop.

Did you see the Maxim lamps hung on the wires?—Yes.

How were they hung? Right across or between the outside and middle wire?—Between the outside and middle wire.

Therefore the connection would be, as in compound parallel, between the outer wire and the middle one?—Yes.

Did you ever at any time see the middle wire go back to the dynamo?—Never.

If it had gone back to the dynamo, must you have known it?—Not necessarily.

Did you do anything to the dynamo?—I altered it in June, putting it to be the same as when it came from Siemens; that would be an alteration giving independent circuits and a common return.

Did you see what the connections were with the dynamo? Was the middle wire connected to the dynamo at that time?—No.

Was the middle ring connected either?—The middle ring was cut off from the armature inside of the machine.

Then it would be one dynamo and not two?—Exactly.

When you got the dynamo what did you do to it?—We used it for experimental work with induction coils.

Did you find what the condition of the dynamo was with regard to the rings?—The middle ring was cut off.

How did you use it at Woodside in 1884?—We coupled it up on a three-wire system. I was then acquainted with Dr. Hopkinson's patent. Early in 1882 Dr. Alexander Muirhead explained it to me. It was run for perhaps a year on Dr. Hopkinson's system.

Was Mr. Andrews at Woodside?—Yes, he occupied premises on the opposite side.

Did Mr. Andrews see the dynamo there?—I don't suppose he did. The metal ring was cut off by McKillock. I saw it done.

Did you at any time from anybody in that workshop ever hear either of the working of the three-wire system being suggested, or anything consistent with it?—Never.

Was it new to you when Dr. Muirhead told you?—Entirely new.

Do you remember seeing anything put across between the outer and the middle wire?—Yes; some of the boys took a piece of wire and connected it across from the outer to the inner wire for the purpose of putting out the lamps. It put out the lamps on the side on which the short circuiting took place and brightened the others.

That could never have happened on the three-wire system?—No.

Was the installation at the Fine Art Gallery superintended by Sir William Thomson?—To some extent, but chiefly by Mr. Bottomley.

Did you find the lamps on one side used to get too bright, and on the other side to go out?—Yes.

Did anybody suggest taking the third wire back to the dynamo?—No, never.

Witness then said that he remembered Lord Kelvin and Mr. Bottomley coming to inspect the inventions at Sauchiehall; the inventions consisting of his arc lamp, Akester's incandescent lamp, plant, and other things. He did not think any new arrangement of wiring was shown them.

Cross-examined by Sir Horace Davey, Q.C.: You were not in the employment of the company at Sauchiehall Lane?—No.

Your visits were not in the company's service?—Most of them were. I was employed by the company, and it was my duty to go to Sauchiehall Lane to superintend the manufacture of my own lamps.

Had you any other business there?—Sometimes I went there to make experiments with the dynamo.

Is it your statement that you purchased the Siemens dynamo from the company?—No. I purchased it from the Railway Electric and Appliances Company, who got it from the National Electric Company.

What is the number of this dynamo?—My impression is it is No. 155.

Did you see the dynamo when it was delivered?—Shortly afterwards.

It had then three connecting rings—one electrical connection with the centre of the coil, for the purpose of connecting three wires to three connecting rings?—Yes.

When do you say that connecting ring was removed?—Immediately after the dynamo was first started.

Which ring do you say was removed?—The broad ring attached to the middle of the dynamo, electrically.

Who removed it?—Mr. McKillock.

Were you present when he removed it?—No; but I saw it before the machine was put together.

How do you know that the ring was not replaced before it was put together?—When I tested the coil of the armature at the end of March, the ring had no connection with the armature.

How do you know that connection was never replaced?—It was not replaced on March 28th. It may have been replaced during my absence at the Crystal Palace.

You were not always at Sauchiehall?—It may have been replaced.

Have you the slightest ground for saying that after March 28th that central ring was not electrically connected with the coil?—It was not connected again when I used the machine at the end of May for experimental purposes with induction coils.

Are you positive it was this machine?—Positive.

You cannot tell me whether between March 28th, the day on which you say you tested it, and May 19th, the connection with the central ring had or had not been restored?—No; all I can say is the machine was not used during that period.

Are you prepared to state that Mr. Andrews's statement that the workshop was lighted with electric light, and that the current through the wires was used for the purpose of manufacturing incandescent lamps from March to June, is altogether incorrect?—Part of that statement is untrue, because there was no lighting of the shop by electricity at any time.

Mr. Andrews was in charge of the shop, and you were a visitor?—Yes.

At this point it was arranged that in the evening a test of Dr. Hopkinson's regulator should be made by Mr. Harrison, in the presence of representatives of both parties, and the Court rose for the day.

Eighth Day, November 24th.

Mr. Rankin Kennedy was further cross-examined, and Messrs. David Graham, David Johnstone, William Macfarlane, James Currie, Dr. Bottomley, and Lord Kelvin, concluded the evidence.

Sir Horace Davey, Q.C., was summing up the case for the defendants when the Court rose for the day.

Gold Trust and Investment Company, Limited v. Electric Tram Car Syndicate, Limited.

On a motion for judgment in default of defence, on Saturday, the 19th inst., Mr. Justice North, at the instance of the plaintiffs, made as against the defendants the usual order in a debenture holder's action, on statement by counsel that the plaintiffs were the registered holders of debentures to secure £300, which had become payable by reason of a special resolution having been duly passed for the winding up of the defendant company.

NOTES.

The Old Students' Association.—The Presidential Address of the Association, entitled, "Human Dynamics," will be delivered by Mr. Ll. B. Atkinson at Finsbury Technical College on November 30th, at 8 p.m.

Institute of Marine Engineers.—Mr. J. Alfred Fisher, general manager of the United Asbestos Company, Limited, recently read a paper before the Institute of Marine Engineers on "The Mining, Manufacture, and uses of Asbestos."

"Electric Light and Power."—On Wednesday, last week, Mr. W. C. Martin delivered a lecture under the auspices of the Dundee Mechanical Society, in the Technical Institute, on "Electric Light and Power."

A New Electric Railway.—In the ensuing session of Parliament a Bill is to be introduced with the object of seeking powers for the construction of an underground electric railway starting at a point in close proximity to Clapham Junction, and passing thence, *viâ* South Kensington, to a point near the Great Western Railway Company's terminus at Paddington. The proposed railway appears to be an extension in the direction of Clapham Junction of the South Kensington and Paddington subway scheme, which was promoted in 1891, but was withdrawn before it was considered by a Select Committee.

Electric Lighting and Fire Insurance.—The following letter appeared in the *Times* from the pen of "A Solicitor":—"The recent fire in Regent Street, which, as I understand from the published accounts, is officially ascribed to "overheating of electric wires," is a fitting opportunity for directing attention to the question whether premises electrically lighted and their contents are covered by the ordinary fire insurance policies. I think it would be well for you to advise all persons who are having the electric light installed to get their existing fire policies endorsed by the offices, 'electric lighting allowed;' otherwise, if a fire occurs, they may be met with a contention that they have added a new risk to the insurance which is not covered by the policy."

The Magnetic Examination of Meteorites.—The interesting line of investigation adopted some little while ago by Mr. Davison in his examination of the magnetic properties of the famous "Welland" meteorite, has recently been applied by Mr. Marcus Baker, of the United States Geological Survey, to the Mt. Joy meteorite, the third largest meteorite ever found in the United States of America. The result of this examination is to show that the meteorite, as a whole, acts as a mass of soft iron, gaining polarity under the inductive action of the earth's magnetism. The lower portion of the north side becomes a north-seeking pole, while the upper part became a south-seeking pole; a fairly distinct neutral line was shown inclined to the horizon at an angle (20°—25°), which is approximately the complement of the local inclination of the dipping needle. This induced polarity shifted with each change in the position of the whole mass, and in general the shifting of the poles took place promptly, though not always at once. Mr. Baker states that his observations suggest the probable existence of an unequal distribution of permanent magnetism. The matter evidently requires further investigation, and it looks as though any results of such investigation would undoubtedly prove extremely interesting. We know too little about these "visitors from space." Perhaps, when we have found out more about them, they may be made to tell us something of the conditions they were under before they came to us.

Overheating of Electric Wires.—By some means or other, last week, the electric wire passing through a book-selling establishment in George Street, Plymouth, became overheated, and set fire to some adjoining woodwork. Luckily the fire was discovered before it had spread very far, and was soon extinguished. The electric wire passes from the main through the area into the shop.

The Continental Edison Company, at Paris.—The accounts for the year 1891 have been approved by the general meeting of shareholders which has just taken place. According to these accounts, the active capital is 13,447,164·25 frs., and the profits 437,291·38 frs. The net profits for the year are more than 12,785·6 frs. above those of the preceding year. From March 31st, 1891, to March 31st, 1892, the number of lights maintained by the sector has increased from 29,792 to 43,942 10-candle lamps. The general meeting fixed the dividend to be paid on each of the 20,000 shares at 20 frs., roughly speaking, or 19·2 frs. net nominal, and 18·41 frs. per shareholder. The dividend to be paid on each of the 14,000 founders' shares is, roughly speaking, 1·788 fr., or 1·7172 fr. more than that of 3 frs. paid in January, 1892.

Electric Mains in Paris.—At the meeting of the Society of Civil Engineers, October 21st, 1892, M. P. Jousselin opened a discussion on the dangers of electric canalisations in towns lighted by gas. The writer, who gave evidence as an expert during the inquiry which took place in consequence of the explosion, which occurred in the Place de la Madeleine, begins by describing this accident, and then proceeded to explain the causes which led to it. These causes may be summed up under two main heads—the formation of short circuits and electrolytic phenomena. M. P. Jousselin has made some experiments with the help of short circuits formed at a pressure of 105 volts. In short, the explanations furnished up to the present are very summary; we must wait for the complete publication of the article. But this will not take place until the case now before the Courts is concluded.

"A Scamper through the States."—This is the title of a very interesting and useful book of information for those intending to pay a visit to Chicago next year. It is written in popular style, and seems a very complete little hand-book for the purpose for which it is intended. Introductory to the detailed descriptions of the exhibition and the surrounding country, is set down a quantity of matter concerning the Polytechnic trips for workmen, &c., at the specially-arranged figure, dates of sailing, arrangements on board, &c. Visitors will naturally need an album or collection of views, and particulars regarding the various places and buildings of note worthy of a visit, and this necessity will be fully met by the illustrated guide under notice. Photographs and drawings form a very important part; they are very numerous, and add largely to the amount of interesting matter placed before the reader. The book is published at the office of the *Polytechnic Magazine*, 14, Langham Place, W., and, we believe, will have an extensive sale.

A Projected High-Speed Electric Railway.—The *Times* correspondent at Vienna states that on 12th inst., an interesting lecture was delivered at the Society of Austrian Engineers and Architects by one of the members, M. Hugo Kostler, on the project of an electric railway for rapid communication between Vienna and Budapest. According to this project, an electric railway would run on the right bank of the Danube at the great speed of 200 kilometres an hour, thus reducing the journey between the two capitals from five hours to one hour and a half. According to the same estimate, the distance between Vienna and Paris, which is now covered in 26 hours, would only require seven hours, and that between Paris and Constantinople would only take 15 hours instead of 65. The trains would have a single carriage, containing 40 passengers, and could be despatched at intervals of 10 minutes. The differences of grade being taken into account, an electric motor of 200 horse-power would be necessary for each carriage. It is said that this system, which is a local invention, will shortly be tried between two large centres of traffic.

Fire.—On Friday evening last it was found that the basement of the premises of the St. James's Electric Light Company in Carnaby Street, Golden Square, was on fire. Several engines were despatched to the scene, and with the aid of a hydrant the mischief was restricted to the portion of the premises in which it originated. Much damage, however, was caused.

Electric Light Accident at the Lisbon Opera House.—In consequence of an accident to the electric lighting at the Lisbon Opera House, where, says the *Times*, there is no other means of illumination, the gala performance on Sunday night in honour of the return of the King and Queen of Portugal from Spain was suspended after the Queen Dowager, the Diplomatic body, and the public were seated.

Penarth and Electric Lighting.—The electric lighting question was considered at last week's meeting of the Penarth Local Board. Mr. J. Rose, of West Bute Street, Cardiff, gave particulars regarding his projected scheme, which would cost about £15,000 to carry out, and so confident was he of success, that his partner and himself were prepared to find one-third of the sum. The matter seems to have been favourably received by the Board.

The Paris Electrical Companies.—We have all heard of the dissensions that have arisen in the Popp Company between M. Popp and the Council of Administration. M. Popp resigned, and it was then seen that the council was composed entirely of German members. The municipal council of Paris objecting to this state of affairs, a revision of the specification is now being prepared, demanding that all councils of administration shall be composed of Frenchmen. The first proceeding of the German council was to dismiss some of the French workmen and replace them by Germans. The rest of the French workmen, it is said, are preparing to strike. Finally, it seems that M. Popp, on his resignation, claimed for himself the works at the Quai de la Gare, on the ground that he furnished all the necessary funds. He wishes to carry them on at his own expense. There is likely to be a long lawsuit about this matter. We shall probably soon hear many other revelations.

Wire-to-Wire Electric Communication.—An article in Tuesday's *Times* deals lengthily with some recent experiments made by Mr. W. H. Preece. On account of the great importance of discovering an easy method of communicating between the shore and lightships, Mr. Preece lately obtained the sanction of the Postmaster-General and of the Treasury to the series of experiments upon which he is still engaged. He proposed to conduct them in three different methods—first, by running a wire along the shore on light poles for a distance of about a mile, and a second wire from stem to stern of the ship, the two acting upon each other inductively through the intervening space; secondly, by suspending a short line over the side of the ship, so that it may dip into the sea in the direction of the end of the shore line, to work by conduction through the sea; and, thirdly, by running out a light cable from the shore to the ship, terminating in a coil at the bottom of the sea, near the ship, but not attached to it, while another coil is placed on board. These two coils are expected to act inductively, and to give ample sound on telephones by means of rapid alternations. The experiments by the first method have been carried to a successful issue within the last few days, the shore wire having been erected along the Welsh coast, commencing at Lavernock Point, a little south of Cardiff, and proceeding for a mile in the direction of Lavernock House. The lightship was represented for the occasion by the island of Flat Holme, in the Bristol Channel; and the line there erected, parallel to the first and three miles distant from it, was about half a mile long. The shore line was furnished with a powerful generator at Lavernock Point, and the island line with a sounder (? telephone, EDS. ELEC. REV.) to receive the messages. The result was, that the words despatched into the mainland wire were heard on the island with perfect distinctness, and that a communication was thus established between these two points, distant three miles from each other, of a kind which would be absolutely independent of light or darkness, of wind or storm, of fog or rain.

The Institution of Electrical Engineers. — Last evening a paper on "Experimental Researches on Alternate-Current Transformers" was read by Prof. J. A. Fleming, F.R.S.

Whitehaven Electric Lighting.—At a recent meeting of the Whitehaven Town Council, it was agreed that the sum of £14,000 be borrowed for the purpose of electric lighting, as sanctioned by the Local Board.

Mason College Engineering Society.—A general meeting of the above society was held in Mason College, Birmingham, on Wednesday, November 16th, when a paper on "Electro-motors in Factories" was read by Mr. R. H. Housman. The paper was followed by a short discussion.

Fatal Electric Lighting Accidents.—Hiram McIlvaine, a lineman employed by the Camden Heating and Lighting Company, while changing the carbon in an electric light at Eighth and Cooper Streets, Camden, N.J., some days ago grasped a live wire. The unfortunate man was jerked from the pole and hurled to the pavement below, dashing his brains out on the stones. When McIlvaine's body was picked up it was found that both of his hands had been charred to the bone by the electric current.

James M'Donald, an electric light engineman employed in the engine room at St. Enoch Railway Station, was instantaneously killed while at work on 20th inst. It is supposed, says the *Glasgow Herald*, that he had been passing the ropes which drive the dynamo in order to oil a bearing cup, and that his clothes had become entangled with one of the ropes. He was thrown about 20 feet against a wall with such force that he died immediately. His left leg was broken and his head dreadfully injured. Deceased was 40 years of age.

New Pacific Cable.—An article appeared in the *Times* of last Saturday regarding the proposals to construct an alternative cable service to Australasia *viâ* the Pacific. Some years ago, the Pacific Telegraph Company was registered with a nominal capital of £2,000,000, but this has never yet been subscribed, and the matter was practically at a standstill. The latest proposals are of French origin, and negotiations have been conducted with the Colonial Governments by the Société Française des Telegraphes Sous-Marin, who have undertaken to lay within 18 months a cable connecting Queensland and New Caledonia. The Brazilian Submarine Telegraph Company, Limited, the Western and Brazilian Telegraph Company, Limited, and the West Coast of America Telegraph Company, Limited, are issuing at £102 per cent. £100,000 £4 per cent. guaranteed debentures of £100 each of the Pacific and European Telegraph Company, Limited. The directors of these several companies offer to their shareholders these debentures in the Pacific Company, the share capital of the latter company being £100,000, which has been taken up by the three companies before mentioned. The proceeds of the debentures will be applied towards the manufacture and construction of a line of telegraph wires between Buenos Ayres and Valparaiso, with a branch between the latter place and Santiago, the capital of Chili, under concessions granted by the Argentine and Chilian Governments, thus by means of the Montevideo and Buenos Ayres lines of the River Plate Telegraph Company, Limited, with which the Western Brazilian Company have a traffic arrangement, connecting the existing duplicated and duplexed system of the Brazilian Submarine and Western Brazilian Companies with the cables of the West Coast Company lying between Valparaiso (Chili) and Lima (Peru). The Brazilian Submarine Company have also a working agreement with the Eastern Telegraph Company, Limited, so that on the completion of the lines of the Pacific Company the cables and lines of the five telegraph companies, together with the traffic arrangement referred to above, will form one direct and united system connecting Europe with the Republics of Chili and Peru. A Reuter's telegram to the *Daily Chronicle* reports that a deputation of influential members of the Ottawa Chamber of Commerce had had an interview with a representative of the Canadian Ministry, at which they requested the Government to urge the imperial authorities to aid the Pacific cable scheme.

Staffordshire Tramway.—In our description last week of the South Staffordshire Electric Tramway, the bogie showing working parts is illustrated on page 606 up-side down, which our readers will doubtless have noticed.

Electric Lighting at Liverpool.—A proposal is on foot for the establishment of a central generating station and system of mains at Liverpool for supplying the electric current throughout the district of Seaforth, Waterloo, Blundellsands, and Crosby.

Telegraph Rates to Australia.—A deputation waited on Lord Ripon at the Colonial Office on Wednesday last week, with reference to telegraphic rates to Australia. Lord Kimberley and all the Agents-General were present, except the Agent-General for Queensland. Sir John Pender was also present.

Personal.—The Postmaster-General has conferred the appointment of engineer-in-chief and electrician to the Post Office upon Mr. W. H. Preece, F.R.S.; the assistant engineer will be Mr. J. Hooke. The double post now occupied by Mr. Preece will be hailed with general satisfaction both inside and outside the Post Office, and we congratulate both gentlemen on their new positions.

Mr. Mundella's Statistics.—Mr. Mundella, in the report of his speech at the Institution dinner, is made to say that the number of deaths from electric lighting in this country (six) is *infinitesimal* compared with the loss which had been sustained in America. There have probably been 100 fatal accidents in the States; but this number, considering that the area over which work is there carried on, is many times larger than that in England, is not infinitely greater than the casualities on this side.

The Electric Lighting of Larne.—A specially-convened meeting of the Larne Town Commissioners was held in the board room of the M'Garel Town Hall on Monday evening last, when the following resolution was passed:—"That a letter be sent as final to Messrs. Gordon & Co., stating that the present lighting of the town was not by any means satisfactory, and that the Commissioners will not pay for light not received by them, and will deduct what they may consider fair and just out of their account for supplying electric light in future."

Newington Vestry and Electric Lighting.—At a recent meeting of the Newington Vestry, the following resolution was unanimously adopted:—"That having regard to the financial success attending the electric lighting in the parish of St. Pancras, this vestry is of opinion that if a competing supply is considered expedient in this parish, the vestry should be empowered to provide that supply, and not another public company; and entertaining this view, the application before the Board of Trade by the County of London Electric Lighting Company, Limited, for a provisional order under the provisions of the Electric Lighting Acts, 1882 and 1888, be opposed."

St. Pancras Electricity Supply.—With reference to our recent article, we omitted to mention that a patent has been taken out by Mr. Andrew Smeet, the chairman of the Electricity Committee, for "Improvements in electrical distribution," covering the system of supply and arrangement of switches which we described, and which has since been reprinted in the pages of our contemporary *Lightning*. In connection with the use of this system, it appears that at St. Pancras some 66 kilowatts are already supplied at the reduced price and controlled by the Baron Smeet switch, while extensions are coming on rapidly. Taking the full output of the station at 12,000 lamps, it would seem that the respectable figure of 10 per cent. motor supply has already been reached, and in view of the number of similar schemes on hand, we must congratulate Mr. Smeet upon the possession of a system which bids fair to be adopted in many districts, similar in kind to that supplied by his vestry.

Provisional Order.—Beckenham Local Board have decided to apply for a provisional order authorising the purchase of land, &c., and the production, supply and sale of electricity for lighting, motive power and other purposes.

The Electric Light at Holsworthy.—The spacious business premises of Mr. John McTaggart Dickson, at Holsworthy, are being extensively altered, and are to be lit by the electric light, the shop alone to be fitted with incandescent lamps of 550 candle-power. The work will be completed early next month.

Liverpool Polytechnic Society.—The seventh meeting of the 54th session was held at the Royal Institution, Colquitt Street, on Monday evening, November 21st, Mr. Thos. L. Miller, Assoc.M.Inst.C.E., President, in the Chair, when a paper on "Electric Traction" was read by Mr. Francis G. Baily, B.A., A.M.Inst.E.E., of University College, Liverpool.

The Electric Light in Glasgow.—The work of completing the installation for the lighting of the streets in the central districts of Glasgow by electricity is being rapidly pushed forward, and already the iron boxes in which the wires are placed have been laid underneath the foot pavements in many of the principal thoroughfares. The lamp pillars for the new light will stand over 21 feet high, and as a first instalment 106 of these lamps are to be fitted up.

The Recent Death from Electric Shock.—We have received a letter from the mother of Thomas P. Lang, thanking us for the comments we made in the leaderette on page 591 of our last week's issue. He has left a widow and two children utterly unprovided for, and we suggest that the company, in whose employ he lost his life, might do something to tide over the widow's difficulties until her return of strength enables her to help herself, she now being quite unable to work, owing to the shock caused by her husband's sudden end. Mrs. Lang writes from 29, Jervis Road, Fulham, if any of our readers feel interested in the matter.

NEW COMPANY REGISTERED.

Scarborough Electric Supply Company, Limited.—This company has been registered with a capital of £50,000 in 5,000 shares of £10 each, to carry on the business of electrical engineers and contractors, and of undertakers for the supply of electricity for lighting, transmission of power, and other purposes, whether public or private; to promote, support and obtain any acts, provisional orders, licenses, and other authorities necessary or desirable for carrying out any of the objects of the company. The subscribers, with 50 shares each, are: Richard Fell Steble, J.P., Scarborough; G. Alderson-Smith, J.P., Scarborough; J. Dale, J.P., Scarborough; J. Woodall Woodall, banker, Scarborough; G. Lord Beeforth, J.P., Scarborough; C. A. Parsons, electrical engineer, Newcastle-on-Tyne; J. B. Simpson, M.E., Blazdon-on-Tyne. The number of directors is not to be less than three nor more than nine. Qualification, £500; remuneration, such sum as the company in general meeting may from time to time determine. Registered by E. F. Ledbetter and Paterson, 144, Leadenhall Street, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Hanley (Staffs.) Electricity Supply Company, Limited.—A letter has been filed at Somerset House from the Brush Electrical Engineering Company, stating that the object of the Hanley Supply Company in registering the same was to apply, in the name of a local company, for a provisional electric lighting order at Hanley; and that as the Corporation of Hanley obtained their own order, no objection has been raised respecting the dissolution of the company. The liabilities are nil, and all expenses of application were borne by the Brush Company.

London and Hampstead Battery Company, Limited.—The annual return of this company, made up to September 29th, 1892, shows that out of a nominal capital of £50,000, divided into 7,000 preference and 3,000 deferred shares, all of £5 each, 3,457 shares have been taken up. There has been £785 called up on each of 157 preference shares, and £600 on 300 preference shares. The total amount of calls received, including payments on allotments, &c., reaches £1,335, and £15,000 has been agreed to be considered as paid.

National Telephone Company, Limited.—The annual return of this company, made up to June 30th, shows that out of a nominal capital of £4,000,000, divided into 30,000 preference shares of £10 each, and 740,000 ordinary shares of £5 each, 30,000 preference and 454,747 ordinary shares have been taken up. There has been £10 called upon 30,000 preference shares, and £5 on the 454,747 ordinary shares. The total amount of calls received reaches £2,573,735.

The Maquay Syndicate, Limited.—At an extraordinary meeting of the above company, held on August 27th, 1892, a resolution to the effect that the syndicate should be wound up voluntarily was proposed, and unanimously carried.

S. Z. de Ferranti, Limited.—At an extraordinary meeting of the members of this company a special resolution was passed, and at a subsequent extraordinary meeting was duly confirmed to the effect "that article 11 of the company's articles of association be amended by altering the figure 5 in the third line to the figure 7, thereby providing that the preference dividend on the shares shall be at the rate of 7 per cent."

Home Telephone Company, Limited.—The annual return of this company, made up to March 28th last, shows that out of a nominal capital of £500 in £5 shares, the whole amount has been taken up, £1 per share having been called.

Pacific and European Telegraph Company, Limited.—The statutory return of this company has been made up to the 7th inst., and shows that out of a nominal capital of £100,000, divided into 10,000 shares of £10 each, 10,000 shares have been taken up. There has been £2 called up on each share and the total amount of calls received, including payments on application and allotment, reaches £20,000.

Poole & White, Limited. — Upon the petition of Arthur Wm. Hervé, a creditor of the above company, made on September 1st last, preferred unto the High Court of Justice, under the Companies' Winding Up Act, and after hearing counsel for the petitioner and the creditors supporting the petition, Mr. Justice Bruce ordered that the said Poole & White, Limited, be wound up by the court under the provisions of the Companies' Acts, 1862 to 1890. Mr. C. J. Stewart, the official receiver, was appointed provisional liquidator to the affairs of the company.

Railway Electric Reading Lamp Company, Limited.—The statutory return of this company, made up to the first inst., shows that out of a nominal capital of £100,000, seven shares have been taken up. The total amount of calls received, including payments on application and allotment, reaches £35.

Ruston, Procter & Co., Limited.—The annual return of this company, made up to June 22nd, 1892, shows that out of a nominal capital of £250,000, divided into 25,000 shares of £10 each, that the full number of shares has been taken up. There has been £10 called up on each of 17,500 shares, and the total amount of calls received, including payments on application and allotment, reaches £175,000. The total amount agreed to be considered as paid is £75,000. There are no calls remaining unpaid; nor have any shares been forfeited.

Roper's Electrical Engineering Company, Limited.—A resolution was passed at extraordinary general meetings held on October 19th and November 4th, to the effect that the company should be wound up voluntarily under the provisions of the Companies' Acts, 1862, and subsequent Acts, and that Mr. W. M. Gray, of Bradford, Yorks, should be appointed liquidator for the purposes of such winding up.

CONTRACTS OPEN AND CLOSED.

OPEN.

Antwerp.—Date not specified. For work in connection with the electric lighting of the Antwerp Basins, for the Belgian Government. Particulars from the Antwerp Dock Authorities.

Chili.—March 1st. The civil authorities of Santiago, Chili, are inviting tenders until March 1st, 1893, for the electric lighting of the town.

Doncaster.—December 3rd. For the supply of electrical and other stores for the Great Northern Railway Company. Particulars from Mr. Martin, stores superintendent, Doncaster.

Dublin.—December 5th. The Great Southern & Western Railway Company are inviting tenders for the supply of stores for 12 months to December 31st, 1893. Among the various items are:—India-rubber and waterproof goods, iron wire and wire work, iron tubes and fittings. Tenders have to be delivered to Mr. Francis B. Ormsby, secretary, Kingsbridge Terminus, Dublin, by 10 a.m. on above date.

Dublin.—December 6th. The Midland Great Western Railway (of Ireland) Company are inviting tenders for stores, the contracts to commence from January 1st, and to terminate December 31st, 1893. Among the various items are:—Brass and copper tubes, plates, sheets, &c., India-rubber goods, iron bars, plates, and wire. Tenders have to be delivered by the above date to the Chairman, Broadstone Station, Dublin. G. W. Green, secretary.

Mondonedo (Spain).—November 26th. For the electric lighting of the city. Particulars from the Minister of the Interior, Madrid.

Santiago (Chili).—March 1st, 1893. For the electric lighting of the city. Particulars from the Santiago Municipality.

Villena (Spain).—December 15th. For the electric lighting of the town for a period of 50 years. Particulars from the Villena Municipal Authorities, Alicante, Spain.

BUSINESS NOTICES, &c.

Messrs. Statter's New Catalogue.—The latest catalogue of heavy electrical machinery is that published by Messrs. J. G. Statter & Co., of Westminster and Millwall. The book is one which indicates the devotion of a great deal of time, trouble, and expense, to its compilation. It is of very convenient size and shape, and the style of binding is very convenient, allowing as it does for the interleaving of additional sectional lists as they are brought out by the firm. The catalogue is divided off into sections as follows:—Section 1 is a collection of general information on matters of payment, but under this section there is also an extremely useful telegraph code facilitating and lessening the cost of ordering by telegram. One word is given for all the preliminary instructions re shipping, port, &c., and also code words for time of delivery. Section 2 deals with high speed engines, engines and dynamos and the necessary accessories. In this section, and throughout the whole of the book, everything is very explicit and illustrations are clear and well printed. Section 3 gives detailed particulars of Statter continuous current dynamos, and in regard to this item a special feature is noticeable. Messrs. Statter have expended considerable time for the convenience of their customers by preparing drawings of foundation plans of the different standards of their dynamos and motors. By the arrangements they have made, engineers and others, instead of having to prepare scale or detailed drawings giving the different dimensions for fixing up the machines ordered, have merely to refer to the catalogue and say thus: Size A., so-and-so; size G., H., C., E, or whatever the special dimension referred to may be, so-and-so; there is thus saved the necessity for enumerating all the confusing names of the various parts. The transmission of power takes up a large amount of space in section 4; constant current dynamos and motors and sectional standards for electric overhead lines, &c., also come under this section. Section 5 refers solely to alternating current machinery; Section 6 to holophotal projectors, similar to the Suez Canal lighting plant. Electrical traction naturally has a section solely for itself, and some handsome illustrations appear. Section 8 describes switches of several kinds, and ammeters, voltmeters, indicators, cut-outs, governors, switches and fuses, switchboards and accumulators, while Section 9 deals with incandescent lamps and various fittings and sundries. The last section in the book at present, regards electric lighting in mines, but Messrs. Statter are now getting out some lists for Section 11, in which they will particularise arc lamps and other accessories, and from time to time other lists will also be added. On the whole the catalogue is a very complete and useful one. The chief fault in catalogues now-a-days is the overcrowding of important matter into small space, but it is certain that this has not been done by Messrs. Statter, everything being very clear and easy to find.

The Electric Light in the West End.—Since our last report a large amount of new work has been taken in hand, among which we may mention a contract that is being carried out at the Cock Tavern, Shaftesbury Avenue.—Messrs. Vaughan & Brown, of Kirby Street, E.C., are carrying out some electrical work at the Palace Theatre, Cambridge Circus.—A contract is also being carried out at "The New York," 62, Piccadilly.—Messrs. B. Verity & Sons, of King Street, Covent Garden, W.C., are at work in the premises of Mr. Henry Field, 68, Piccadilly, while Messrs. E. L. Berry, Harrison and Co., of Whitcomb Street, W.C., are fitting up the premises of Messrs. J. Kerly & Co., of 19, Cockspur Street, W.C. — Electric lighting work is being carried out in the premises of Messrs. Wetherall and Green, auctioneers and surveyors, Chancery Lane, W.C.—Christ Church, Victoria Street, Westminster, is now lighted by electricity, incandescent lamps of 100 C.P. being employed.—Messrs. Allen and Mannock, of Mount Street, Berkeley Square, are engaged at 63, Curzon Street.—A contract is also being carried out at some new residential chambers at 45, Mount Street. — Messrs. Edmundson's, Limited, of Great George Street, Westminster, are fitting up 44, Portman Square.—Messrs. E. P. Allam & Co., of Dashwood House, Old Broad Street, are fitting up the premises of Mr. R. F. Elms, hairdresser, at 73, Baker Street.

Hove Electric Lighting.—On Saturday last, the 19th inst., the New Hove Electric Lighting Company, Limited, who have acquired the statutory powers under the Board of Trade Provisional Order, granted to the Hove Commissioners in 1890, commenced the supply of electric current to the residents in about two miles of streets from a temporary central station at Holland Road. The contract for this work was placed with Messrs. Crompton & Co., Limited, exactly 90 days before the date of first supply, and the two miles of mains were laid in 60 days, an extremely smart piece of work. A large number of private consumers' houses are already wired for the electric current, and others are being wired. Some 1,300 lamps are connected up, thus ensuring an income of some £700 to £800 per annum from the commencement. The Hove Commissioners propose lighting the Town Hall and Municipal Buildings with some 600 lights, and they also intend to erect a large number of arc lamps in the streets. Altogether the prospects of the new company are extremely promising. Messrs. Crompton & Co., Limited, are under contract for completing the laying of mains in the compulsory area by March 19th, and they have also to erect the permanent generating and distributing station.

Mill Electric Lighting.—Electric lighting has been adopted in the York Road mill of the York Street Spinning Company, Limited, Belfast. In this mill an installation of 65 32-candle-power and 20 16-candle-power incandescents, together with dynamo, have lately been erected and successfully set to work by Messrs. W. H. Allen & Co., of York Street, Lambeth, S.E. The dynamo has an output of 65 volts and 150 ampères when running at a speed of 700 revolutions per minute, and is furnished with a fast and loose pulley and a third or outer standard, with belt tightening gear. The switchboard and connections are so arranged as to permit of the easy extension of the installation. The insulation of the cables and fittings is specially adapted to withstand the effects of the hot damp atmosphere of the spinning room, and throughout the utmost care has been taken to adapt the method of lighting to the circumstances of the case. The whole installation affords a fine illustration of modern mill lighting.

Country House Lighting.—Messrs. Drake & Gorham have a considerable number of country house installations in hand at the present moment, and have lately added to their already long list of contracts in progress, among which we notice the country house of Sir Gervas Glyn, Ewell, Surrey, Mr. Hallett, at Orpington, Mr. Herman, at Cambridge, and Mr. Tiarks, at Chislehurst. The contracts for the lighting of the residences of the Right Hon. Baron Henry de Worms, M.P., at 42, Grosvenor Place, and Sir E. H. Carbutt's house, at 19, Hyde Park Gardens, have also been placed with Messrs. Drake & Gorham, together with 54, Lowndes Square, for Mr. Nicholas Wood, 75, Eaton Square, for Lord Knutsford, and 13, Eaton Square, for C. C. Dowling, Esq. In the City we notice they are carrying out 55, Old Bailey, for Messrs. Dickinson & Co., 6, Moorgate Street, for Messrs. Schwann Bros., and 145, Leadenhall Street, for Messrs. Schroder & Co.

Bazaar Lighting.—A very successful bazaar was held last week at the Vestry Hall, Turnham Green. The Dowager Countess of Winchelsea and Nottingham, in the presence of a numerous company, performed the opening ceremony. The stalls were tastefully illuminated with incandescent lamps, the current being derived from accumulators. The whole of the electrical gear was lent by Mr. Ronald A. Scott, M.R.I., of Acton Hill; whilst the installation was carried out by Messrs. Worthington, Leslie, Bigland, and Denny, under the supervision of Mr. Cyril Davies, all being members of the Acton Hill Engineering Works, and who kindly gave their services. Owing to a ball on the previous evening, the work had to be carried out during the night. Lady Winchelsea expressed herself very satisfied with the effective illumination of the hall.

The Collier Audible Telephone Syndicate, Limited.—The creditors of the above company are required, on or before December 16th, 1892, to send their names and addresses, and the particulars of their debts or claims, and the names and addresses of their solicitors (if any), to Godelroi Drew Ingall, of 4, Coleman Street, in the City of London, the liquidator of the said company, and, if so required by notice in writing from the said liquidator, are, by their solicitors, to prove their said debts or claims at such time and place as shall be specified in such notice, or in default thereof they will be excluded from the benefit of any distribution made before such debts are proved.

Lighting and Cooking by Electricity.—A well attended conversazione was held on the 17th inst., at the Kensington Town Hall, Lord and Lady Chelmsford receiving the guests. Some recent advances in electric lighting and cooking were illustrated by Messrs. Faraday & Son and Messrs. Crompton & Co. The first-named firm exhibited a series of artistic fittings, including many of the new devices for shading the over brilliancy of the light, while Messrs. Crompton demonstrated that elementary cooking and heating can be performed wherever the mains for lighting are available.

Private Electric Lighting.—Messrs. Ernest Scott and Mountain, of Close Works, Newcastle-on-Tyne, have recently fitted the residence of Mr. H. J. Younger, Benmore, near Kilmun, Argyleshire, throughout with the electric light. About 180 lamps are distributed throughout the house. The installation has been carried out under the supervision and to the specification of Mr. W. A. Bryson, consulting engineer, Glasgow, Mr. M. B. Mountain, of Glasgow, having supervised on behalf of Messrs. Scott and Mountain, the erection of the work.

The Electric Light in South London.—Since our last report we note that Messrs. Robert G. Ivey & Co., of Portpool Lane, E.C., are carrying out electric lighting work in the premises of Mr. Layman, 271 & 273, High Street, Borough, S.E.—Messrs. Marryat, Lillywhite & Co., of Dashwood House, E.C., are fitting up the South London Dancing Academy, Blackfriars Road, S.E.—A contract has also been recently carried out in the premises of Messrs. Redman & Sons, 190, High Street, Borough, S.E.

The Electric Light in the City.—At a meeting of the Commissioners of Sewers, a letter was read from the City of London Electric Lighting Company relative to the progress made in lighting the City by electricity. The letter stated that the total number of lamps for lighting purposes was 515, but in the economising of space the engineer had saved 44 lamps, which would be placed where they were needed. Several of the thoroughfares had been lighted before the expiration of the contract time.

The Plymouth and District Pulsion Telephone Company, Limited.—A general meeting of the members of the above named company is to be held at 104, Old Town Street, Plymouth, on December 20th, at twelve o'clock, noon, for the purpose of having an account laid before them, showing the manner in which the winding up has been conducted, and the property of the company disposed of, and of hearing any explanation that may be given by the liquidator.

Siam Central Station Plant.—The Brush Electrical Engineering Company, Limited, have received advices by cable from their representatives at Bankok that the central station plant supplied by them to the Siam Electric Light Company has undergone the fortnight's trial prescribed by the arbitrators under their award, with complete success and to the entire satisfaction of the experts, and that the balance of monies due thereon has been paid over by the treasury.

Iron for Armatures.—Messrs. Turner Brothers inform us that having noticed our article in the ELECTRICAL REVIEW, of the 18th inst, in which Prof. Ryans speaks of the importance of getting good qualities of iron in armatures, they are supplying an excellent iron for armatures of uniform quality.

R. C. Cutting, Douglass & Co., Limited.—At meetings held on September 20th and October 7th, it was agreed that the company be wound up voluntarily, Mr. S. J. Skelton, of Wardrobe Chambers, E.C., being appointed liquidator.

CITY NOTES.

The Swan United Electric Light Company, Limited.

THE tenth annual report of the directors, together with a statement of accounts for the year ending September 30th, 1892, to be presented at the ordinary general meeting of the company, to be held at the Cannon Street Hotel, London, on Tuesday, November 29th, 1892, reads as follows:—The profit and loss account for the year shows a credit balance of £34,840 11s. 11d., which, together, with £8,010 3s. 10d. brought forward from the last account, makes disposable the sum of £42,850 15s. 9d. An interim dividend in respect to the first half of the year amounting to £14,558 9s. 8d. has already been paid. The board proposes that a further sum of £21,467 8s. 4d. be divided, free of income tax, and that £6,824 17s. 9d. be carried forward. The distribution of this amount in accordance with clause 77 of the articles of association will work out at 4s. 2¾d. per share on the 78,949 ordinary shares of the company, £3 10s. paid, and at 4s. 11¾d. per share on the 19,750 £5 fully paid, being equivalent to 10 per cent. per annum on the partly paid, and of slightly under that rate upon the fully paid shares. The dividend will be paid upon the register as it stood upon November 15th, and the warrants will be issued on December 13th. The litigation on the German patents of the company having happily terminated, and the bulk of the capital of the company being now invested in the Edison and Swan companies in Great Britain and France, the board believe that the time has arrived when a fusion of the residuum of the foreign business of the Swan Company with the British Edison and Swan Company may be effected with advantage to both interests, and negotiations are pending with a view to effecting some arrangement in this direction. The directors desire to record their sense of the loss which the company have sustained by the death of Mr. F. R. Leyland, deputy-chairman of the company. The directors have elected Major Samuel Flood Page, who had been secretary and manager of the company for several years, to a seat on the board. The directors who retire by rotation are Mr. J. S. Forbes and Mr. E. W. Batt, who being eligible, will offer themselves for re-election. Messrs. Welton, Jones & Co., the auditors, will also retire, and will offer themselves for re-election.

The Hove Electric Lighting Company, Limited.

THE first meeting of the shareholders of this company was held on Monday last at the offices, Mansion House Buildings, Colonel Felgate, R.E., in the chair.

In moving the adoption of the report and accounts, the chairman said that Messrs. Crompton & Co., Limited, had so far satisfactorily carried out the first portion of their contract with the company that the temporary station was practically complete. Two miles of mains had been laid, and everything done to the satisfaction of the Hove Commissioners. The actual supply of current was commenced on Saturday. From the number of applications received from customers and other indications, the directors felt that the future success of the company was practically assured. Up to the present time applications had been made for 1,300 8-C.P. lamps, and negotiations were in progress for the lighting of the Town Hall and the streets at Hove. —Mr. Allbright proposed a vote of thanks to the chairman, which was seconded by Mr. Sutton, and carried.

The Scarborough Electric Supply Company, Limited.—The prospectus of this company offers for subscription a first issue of £2,000 shares of £10 each. The nominal capital of the company is £50,000, in shares of £10 each. The company has been formed for the purpose of supplying electricity for lighting, motive power and other purposes in the town of Scarborough. The sum of 500 guineas will be paid to the Corporation by the company for expenses incurred by them in obtaining the provisional order, which now becomes the property of the company. The maximum price of electricity for private consumers will be 7d. per unit, and for street lighting, 6d. per unit. It is estimated that an expenditure of not more than £20,000 will be required to enable the company to commence operations on a proper scale, and it is expected that the light will be running by the beginning of June, 1893. The directors are Lieutenant Cole; R. F. Steble, J.P.; G. Alderson-Smith, J.P.; John Dale, J.P.; John Woodall Woodall, M.A., F.G.S., J.P., C.C.; George Lord Beeforth, J.P.; J. Bell Simpson, J.P.; Hon. C. A. Parsons; A. A. Campbell Swinton. The managing director is Mr. Campbell Swinton; Mr. John Hall is secretary, *pro tem*, and the temporary offices are at 102, Westborough, Scarborough. Applications for shares are to be made not later than December 3rd.

Official Announcements re Companies.—According to a notice in last Tuesday's *London Gazette*, the following companies are to be struck off the register, and the companies will be dissolved at the expiration of three months, from the 22nd inst., unless cause is shown to the contrary:—Durand Electric Petroleum and Gas Engine and Manufacturing Company, Limited; Johannesburg Electricity Supply Company, Limited; Morgan's Automatic Electric Signal System Syndicate, Limited; Universal Electric Light and Power Trust Corporation, Limited.

Pacific and European Telegraph Company.—The directors of the Brazilian Submarine, Western and Brazilian and West Coast of America Telegraph Company are offering to the shareholders in those several companies, for subscription, £100,000 four per cent. guaranteed debentures of £100 each, at £102 per cent., in the Pacific and European Telegraph Company. Further particulars will be found in our Notes columns.

The City of London Electric Lighting Company, Limited.—The City of London Electric Lighting Company have furnished the following particulars of the present position of their capital: Authorised share capital, £400,000 in £10 ordinary shares; £400,000 in £10 six per cent. cumulative preference shares. Issued: £400,000 ordinary shares, fully paid; £200,000 preference shares, £4 paid, next call of £2 due January 16th, 1893.

Electric and General Investment Company.—At a meeting of the directors held last Tuesday, Mr. George Herring was unanimously elected chairman of the company in succession to the late Duke of Marlborough, and the board at the same time declared an interim dividend at the rate of 20 per cent. per annum for the six months ending the 30th inst. on the ordinary shares, payable on or after December 15th next.

Spanish National Submarine Telegraph Company.—The numbers are announced of 89 bonds, amounting to £8,900, of the Spanish National Submarine Telegraph Company, Limited, 6 per cent. mortgage debentures, drawn for payment at par on or after December 31st next, at the offices of the company, 106, Cannon Street.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending November 20th, 1892, amounted to £899; corresponding month, 1891, £792; increase £107; total receipts to date, 1892, £17,007; corresponding period, 1891, £15,367; increase £1,640.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending November 18th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, amounted to £2,965.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.	Closing Quotation, November 17th.	Closing Quotation November 24th.	Business done during week ending November 24th, 1892	
					Highest.	Lowest.
195,100*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	100 —103	100 —103	102½	...
1,247,720*l*	Anglo-American Telegraph, Limited	Stock	50⅛— 51⅛	50⅛— 51⅛	50⅝	50⅛
2,876,140*l*	Do. do. 6 p. c. Preferred	Stock	91 — 92	91 — 92	92⅛	91¾
2,876,140*l*	Do. do. Deferred	Stock	11⅛— 12	11⅛— 11⅜	11⅜	...
130,000	Brazilian Submarine Telegraph, Limited	10	10¾— 11¼	10¾— 11¼	11⅛	10 15/16
34,600*l*	Do. do. 5 p. c. Bonds	100	101 —104	101 —104	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	105 —109	106 —110	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3 — 3½	3⅛— 3⅜	3⅜	3 3/16
75,000	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2¼— 2½	2¼— 2⅜	2⅜	2¼
40,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3 — 4	3 — 4	...	...
50,000	City and South London Railway, Nos. 1 to 50,000	10	3 — 4	3 — 4	3⅜	3½
40,000	City of London Elec. Lighting Co., Ltd., Ord. 40,001-80,000 ...	10	10½— 11	10¼— 11	10⅜	10⅜
$7,716,000	Commercial Cable, Capital Stock	$100	181 —183	183 —185	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	1/— 3/8	3/16— 5/16	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos 1 to 20,000	5	5¼— 5⅝	5⅜— 5⅝	...	...
16,000	Cuba Telegraph, Limited	10	11½— 12½	11½— 12½	...	...
6,000	Do. do. 10 p. c. Preference	10	17½— 18½	17½— 18½	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3 — 3½	2½— 3½	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	11½— 11¾	11½— 11⅝	11⅝	11½
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅜— 15	14⅜— 15	15	14⅜
70,000	Do. 6 p. c. Preference	10	15¾— 16¼	15⅜— 16½	16⅛	...
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	107 —110	107 —110	...	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	109 —112	109 —112	111	110
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	14⅜— 15	14⅜— 15	15	14¾
70,600*l*	{ Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326 }	100	104 —107	104 —107	...	...
250,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	104 —107	104 —107	...	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	109 —112	109 —112	110¼	...
122,400*l*	{ Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343 }	100	104 —107	104 —107	...	...
163,700*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	104 —107	104 —107	...	...
300,000*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	103 —106	103 —106	105¼	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	3⅜— 4¼	3½— 4	3 15/16	3⅜
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
100,000	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	3/8— 5/8	3/8— 5/8	9/16	...
82,395	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	1½— 1⅝	1½— 1⅝	1 9/16	1⅜
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1/— 2/	1/— 2/	2/	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	2½	...
180,227	Globe Telegraph and Trust, Limited	10	9⅞— 10⅛	9¾— 10	10	9 13/16
180,042	Do. do. 6 p. c. Preference	10	15 — 15½	14⅝— 15⅛	15½	14⅝
150,000	Great Northern Tel. Company of Copenhagen	10	18¾— 19¼	19 — 19⅓	...	...
210,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108	104 —107	...	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	4½— 5½	4½— 5½	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	9 — 10	8 — 9	...	...
50,000	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	21½— 22½	21 — 22	22	21½
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	102 —104	102 —104	...	...
17,000	Indo-European Telegraph, Limited	25	43 — 45	43 — 45	43½	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	2½— 3½	2½— 3½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	6 — 7	6 — 7	...	...
30,000	†Liverpool Electric Supply, £3 paid	5	3 7/16— 3 9/16	3 7/16— 3 9/16	...	...
10,000	Do. do. fully paid	5	5 1/16— 5 3/16	5 1/16— 5 3/16	5⅛	4⅞
38,348	London Platino-Brasilian Telegraph, Limited	10	6 — 7	6 — 7	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	107 —110	107 —110	108½	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	6½— 7	6½— 7	...	...
50,000*l*	Do. 5 p.c. debentures, 1 to 5,000 in bonds of £10, £20, £40	...	103 —106	103 —106	...	...
447,234	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜— 5	4⅜— 5⅛	5 1/16	4⅞
15,000	Do. 6 p. c. Cum., 1st Preference	10	14 — 15	14 — 15	14⅜	14½
15,000	Do. 6. p. c. Cum. 2nd Preference	10	13½— 14	13⅜— 14¼	14⅛	13 15/16
726,477*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	111 —113	112 —114	113	112⅜
48,800*l*	New Telephone, Limited, Nos. 25,901 to 74,700 ... (£2 paid)	10	3⅞— 4⅛	3⅞— 4⅛	4 1/16	3 15/16
6,318	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	5 — 6	5 — 6	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	1/16— 3/16	1/16— 3/16	...	...
10,802	Reuter's Limited	8	7½— 8½	7½— 8½	8	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	8¼— 8⅝	8 — 8½	8 1/16	...
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	8 — 8½	8 — 8½	8 1/16	...
3,381	Submarine Cables Trust	Cert.	117 —121	116 —120	116½	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	3¼— 3⅜	3¼— 3⅜	3⅜	3⅜
37,350	Telegraph Construction and Maintenance, Limited	12	45 — 47	45 — 47	46½	45⅜
150,000*l*	Do do. do. 5 p. c. Bonds, red. 1894	100	103 —106	103 —106	105⅜	...
58,000	United River Plate Telephone, Limited	5	2¼— 3	2¼— 3	2 15/16	2⅜
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	90 — 100	90 — 100	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	6½— 7½	6½— 7½	7½	...
260,900*l*	Do. do. do. 5 p. c. Debentures	100	100 —103	100 —103	100⅜	100
30,000	West Coast of America Telegraph, Limited	10	2½— 3½	2½— 3½	3	2⅜
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	103 —107	103 —107	...	...
64,242	Western and Brazilian Telegraph, Limited	15	8 — 8¼xd	7½— 8	8 1/16	7⅞
33,129	Do. do. do. 5 p. c. Cum. Preferred	7½	6 — 6½xd	5⅝— 6½xd	6⅝	5 7/16
33,129	Do. do. do. 5 p. c. Deferred	7½	2¼— 2⅝	1⅜— 2¼	2 3/16	2
184,100*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	106 --109	106 —109	...	...
230,100*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	106 —109	106 —109	...	...
88,321	West India and Panama Telegraph, Limited	10	1¼— 1½xd	1¼— 1½xd	...	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	10 — 10½xd	10 — 10½xd	10½	10⅛
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	8½— 9½xd	8½— 9½xd	9	...
80,000*l*	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	104 —107	104 —107	...	...
$1,536,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	120 —125	120 —125	120⅛	...
171,000*l*	Do. do. 6 p. c. Sterling Bonds	100	100 —103	100 —103	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5⅜— 6½	5½— 6	6⅛	...

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange. BANK RATE OF DISCOUNT.—3 per cent. (October 20th, 1892).

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Blackpool Electric Tramway Company, Limited, £10 (£6½ paid) 7½—7⅞.—Electric and General Investment, shares of £5 (£1 paid), 2⅜—3⅛.—Founders' shares, 200—225.—Elmore Foreign and Colonial Copper, Founders shares, 6¼—7½.—European Sims-Edison Torpedo Company, shares £20 (fully paid), 20—20½.—Founders' shares, 10—20.—Halifax and Bermuda Cable 4½ per cent. bonds 80—90.—House to House Company (£5 paid) 2⅜—3⅛.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5—5⅛, 1st Preference Cumulative 6 per cent., £5 (fully paid), 5⅛—5⅜.—Liverpool Electric Supply Shares of £5 (fully paid), 5⅛—5⅜.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅛—¼.—Queen Anne's Mansions Lighting and Heating, Deferred shares of £10 (fully paid), 10—⅛.—Do. 4½ per cent. preference shares of £10 (fully paid), 10—⅛.—Do. Debentures, 102—⅛.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), ⅛—¼.—£5 Preference (fully paid), 2⅛—3,

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

AN ordinary general meeting of this Institution was held on Thursday, November 10th, 1892, Prof. W. E. AYRTON, F.R.S., President, in the Chair.*

The minutes of the last ordinary general meeting having been read and approved,

The PRESIDENT alluded in feeling terms to the recent death of Mr. E. Graves.

Major-General WEBBER proposed, and Mr. C. E. SPAGNOLETTI seconded:—"That this meeting desires to record its deep sense of the loss sustained by the Institution in the death of Edward Graves, Esq., Past-President and Hon. Treasurer, and further desires to express its deep sympathy with Mrs. Graves, and other members of the family, in their bereavement."

The motion was put to the meeting, and carried unanimously.

The SECRETARY read a letter from a committee representing the American Society of Civil Engineers, the American Society of Mechanical Engineers, the American Institution of Mining Engineers, and the American Institute of Electrical Engineers, offering a hearty welcome to members of the Institution who might attend the Columbian Exposition to be held in Chicago next year, and stating that the homes of the several societies named would be open to such visitors as were duly accredited through the secretaries of their respective associations.

The discussion on Mr. Swinburne's paper, on "The Problems of Commercial Electrolysis," was then commenced.

Mr. C. F. COOPER, in describing the Hermite process, said: The electrolyser consists of a galvanised cast-iron box, and of a certain number of electrodes: the anodes being of platinum gauze mounted in ebonite frames. The platinum is cast into a lead frame and then fixed in the ebonite, and then bitumen is run in on the top, and that has proved considerably satisfactory. There is practically no attack on the platinum anode. The process has been in use for six years at Messrs. Montgolfier's mill, and out of ten electrolysers, not one set of anodes has been renewed in the whole six years' working. The gentleman who takes a leading part and puts two electrodes into sodium chloride, and decomposes that sodium chloride, generally talks about it as if it were a simple affair. So it is; but it is not at all simple when you get into paper where you have varying conditions every five minutes. The pulp is of all sorts—let us say esparto, wood pulp, soda sulphate—all these things you can never tell, from one minute to another, what state your bleaching solution is in. I cannot conceive that it is possible to observe the chemical conditions of that solution for more than half an hour together. The Hermite process is, as probably everybody knows, based on the decomposition of magnesium chloride. The process is essentially a continuous one. The solution of magnesium chloride in a top tank runs down to a bottom tank. We use a thousand ampères of 5 volts; we occasionally run the tanks as many as eight in series, but we prefer five in practice. The decomposition takes place in the bottom tank, and runs down into the poacher; it is washed in the ordinary washing ground one sees in a paper mill; the thing goes on continuously in that way. When the pulp is bleached, of course there is a certain amount of solution left in the pulp that is to be treated and got back again, because one of the principal points in the Hermite process is that we use the same solution over and over again. It is run down from the poacher either into a drainer or over a press plate. A press plate will take out, let us say, from possibly about 40 per cent of moisture, and it is necessary to cast the pulp which is to be dealt with over a press plate in the first instance, and then, after bleaching, to pass it over another press plate, so that we keep the amount of solution in circulation the same. In dealing with carbon, I have used various sorts years ago, and lately we have always found that it disintegrated on the water line, that irrespective of the carbon coming out, it is apt to disintegrate, and you get small specks of black in your pulp, which renders it entirely useless. We have tried a great many experiments with it, but always came to that difficulty, that instead of a bleaching solution we have practically a dyeing solution. We have had the same difficulty again in dealing with the pipes and conduits which convey our solution from one part of the mill to the other. Some years ago, in using the process, we dyed many tons of our pulp a beautiful green. That was due to the copper in the washing ground. We had to take all the copper away and put on zinc, and then again we used occasionally to dye a very nice rich red, from the fact of peroxide being present.

Mr. C. K. FALKENSTEIN: Mr. Swinburne has mentioned electric tanning. He says when hides are put into tan liquor the interstices between the pores or fibres of the hides are very close indeed. Perhaps there is a little difference in that case in the preparatory or liming process; the cementing substance which joins the fibres together is dissolved away by means of the lime, which, so to speak, separates the fibres, and leaves the hide pretty porous for the liquor to go in between. Well, when the hide goes into tan liquor the tanning goes on very rapidly, for the reason that the pores are filled with water and organic salts, which diffuse very much more rapidly than tan liquor would, as tan liquor is a colloid body. Supposing the tanning goes on very rapidly in the first two or three days, it is much slower afterwards, because those containing water and salts are no longer present in such large quantities. Supposing, now, a current of electricity passes through the hides, the electricity impels the tan liquor in the same direction as the lines of force flow, and therefore the diffusion is increased by virtue of this flow. If the hides intercept it, that, also, cleanses the pores of the hides, and allows the tanning to go on more rapidly. This endosmosis is pretty considerable, being due, perhaps, to the molecular construction of the tanning acid, and the fact that it has a fairly high resistance, and therefore at a comparatively high difference of potential can be employed without a great current, and therefore great expenditure of energy in the process. It has been found in electric tanning that after the current has been stopped the process continues, the rate of absorption continues at a high abnormal rate, this being due, no doubt, to the fact that the pores have been cleansed by endosmosic action. That accounts for the increased diffusion, but there is another effect which might be noticed, and that is, that electricity is of the nature of vibration, and therefore vibration of the molecules of the liquid tend to accelerate or help the combination of the peroxide and the gelatine. Mechanical agitation, too, has been commented upon. I think the function of that can be divided into two—first of all, to mix the liquor and render it of uniform strength; and, secondly, if it be sufficiently strong it cleanses the hide, therefore opens the pores on the outer side of the bend, and thus promotes diffusion.

Mr. STEPNEY RAWSON: Mr. Swinburne puts the cost of the kilowatt-hour at about one farthing, and he says it will appear ridiculous in connection with central stations. I think that unless he has some figures arising out of his visit to Bridgeport to confirm the farthing per hour, it will appear not ridiculous, but very small, to those who are engaged in commercial electrolysis; but, at the same time, he does mention the best engines and modern dynamos. The modern dynamo—we know pretty nearly what that is capable of, but we do not quite know what the modern engine is capable of. An exceedingly good authority told me once that in a succession of tests he made on the commercial working, the efficiency ran anywhere between 28 lbs. and about 4 lbs., so that there is a certain margin. I know that people are very fond of putting down on paper 2½, and in France a kilo. corresponds so nearly with that, that they always call it a kilo., but it is almost impossible to get it in practice. Then Mr. Swinburne very wisely makes his estimate at the dynamo terminals; I say wisely, because in actual working one of the greatest enemies is leakage. There is no doubt, theoretically, it is easy to get rid of it. There are a thousand ways in which leakage takes place which will surprise even an old hand. Many cases within my experience have occurred where it has puzzled old hands to find out what is going on; moreover, another great difficulty is the large number of parasitical currents set up, and you may hunt round for weeks before you find out where they arise. Therefore, although at the dynamo terminals you may arrive at a farthing, I think by the time the current has, so to speak, got back again, you will find it takes a great deal more. With regard to the carbon, that, no doubt, is a source of difficulty, and many people have had troubles with it. I remember having got hold of a very good sort of carbon that I thought would do very well for the purpose, but instead of that I was surprised at the result. With a very heavy current density it behaved tolerably well; that was a current density of 100. When I got down to 10, it disintegrated very much faster. This is the drawback, but no doubt it is extremely difficult to get carbon to work, and it surprised me. The fact which Mr. Swinburne has been able to put before us very clearly is, that a new process must be marvellously good on paper before it is worth anything commercially, and that it is of no use to exploit it as a commercial process unless you take that point to start from. Regarding zinc and lead, Mr. Swinburne mentioned the difficulty of treeing in both those things. The arrangement of burnisher which the Elmores used has proved very successful in removing that difficulty. I have seen a solution of zinc deposited with a sulphate solution with a porous partition come out very definitely indeed, not, of course, as well as copper, and you can see the attempt to tree, but you can also see the success of the burnisher in keeping that down, and I rather think that the deposition of zinc from the sulphate solution with the burnisher working will turn out a fairly good process, because there is a very considerable margin in that work. In the same way, the treeing of lead can be fairly easily kept down. I hope that anyone who is interested in seeing the Elmore process in full work, will pay a visit to the French works, where the work is going on on a large scale and with beautiful results, results of commercial working, and on such a scale as to enable people to say "That is an average product coming from the factory and not at all selected articles of any sort or kind."

Mr. C. F. CROSS: So long as electrolysis was confined to the actual separation of bodies in a condition to be weighed, there could be no doubt, of course, as to the efficiency of the current, and no doubt either as to the measurement of the current in the terms of the product obtained. But when you have to get that product to do work in a transitional state, and having done work to revert to something like the *status in quo*, there came, of course, an element of doubt and difficulty. You had to catch a particular element, namely, oxygen, flying, and that led to some very remarkable results, which we have been latterly enabled to establish, but which, at the time, naturally led to difficulty and dispute. The essential point was—it was not a new factor—the chemical work done of a particular kind in the terms of watts expended to produce that work. Now, of course, there were a large number of subsidiary points raised connected with the mechanism of the actual decomposition of magnesium chlorine by the current. From the point of view of this meeting, I don't think that is of much importance. Now, the making of a ton of bleaching powder, could be effected on the electrolytic plan, at a cost of from £2 10s. to £4. That is to say, given a certain amount of bleaching work to do, and requiring a certain amount of bleaching powder to do it, to the weight of one ton, and costing, of course, from £7 to £8 at then rates, it could be done now at from £2 10s. to £4. Now Dr. Hurter, passing through what I may term cumulative criticism, and finishing his point with his last result, arrived at the figures £22 to £42, which was a multiplication of our

* Abstracted from report of proceedings supplied by Institution of Electrical Engineers.

figures by a considerable whole number. If Dr. Hurter had differed from us by any considerable percentage, we should have thought it a serious matter; but, when he multiplied our figures by a big number, we knew there was something totally wrong. His figures were based (1) on current efficiency, and (2) the bleaching effect per unit of available chlorine, or the oxidising effect tested by the ordinary chemical reagents. Dr. Hurter's position with regard to these factors was this: he found that the electrolysis was conspicuously wasteful, and the efficiency, that is, the yield of chlorine per ampère was only 14 per cent. of the theoretical, and then that the bleaching product was magnesium hypochlorite pure and simple, and that it could not exceed in bleaching effect the corresponding calcium compound or bleaching powder. These are the points upon which he differed from us. We found always from 70 to 90 per cent. of the current efficiency, and the compound produced we clearly showed was not the ordinary chlorine. We also showed that there was formed at the cathode an active oxidising compound, and this, stirred into the solution, was dissolved, and no doubt contributed largely to the particular efficiency of the solution. Now, since the publication of these papers, by which the mechanism of electrolysis was fairly established, we have carried out experiments on the mechanism of the bleaching process itself. We found that when you bleach with bleaching powder, and the matter required rather careful finding, that instead of being confined to considerable oxidation it took, also, the form of an actual combination of chlorine with the fibre constituents. Now, in these experiments we compared bleaching powder in the ordinary chemical process and the electrolysis in Hermite's method, and we found that 26 per cent. of the bleaching powder was used in the chlorination effect; 14 per cent. of the total used went into this bye-path, or in some other direction, but, with the electrolysed solution prepared by Hermite, there was no chlorination at all. It is rather interesting to find that, when carried out under these conditions, the electrolysed solution does enable you to revert to simple solution of magnesium hypochlorite finally, and therefore the bleaching process is limited to oxidation pure and simple, and therefore we can see why bleaching under the one set of conditions is totally different from, and much more economical than, under another set of conditions. The process is an undoubted and proved success.

Mr. DESMOND FITZGERALD: Mr. Swinburne says: "Unfortunately, peroxide of lead is reduced by hydrochloric acid, and it seems to be impossible to electrolyse salt without producing some free acid at the anode." I think this statement as to the production of free acid is perfectly correct, if you take any ordinary salts. Every sample I have tried has contained a considerable proportion of sulphate of soda. In that case acid would be produced at the anode, and the sulphuric acid reacting on the sodium chloride would, of course, produce hydrochloric acid; but in practice it is, of course, the easiest thing possible to maintain the solution at the anode in the alkaline condition to any required extent. There need never be any free acid where chlorine is being evolved; but supposing that hydrochloric acid were evolved, peroxide of lead in the form of lithanode is perfectly indifferent to the action of hydrochloric acid, so long as the current is continued. If you place peroxide of lead or a plate of lithanode in hydrochloric, you obtain chloride of lead, and chlorine is evolved; but if you make the peroxide the anode, chlorine is evolved, but no chloride of lead is produced. I have a plate which, prior to coming here, I took out of a solution of hydrochloric acid, in which it had been used as anode, and producing chlorine for eight or ten hours. The plate is not affected, and that would also be the case if it had been left two or three days, or two or three weeks, for the matter of that. I think the only person here capable of speaking from actual experience, from the use of lithanode as an anode employed on a large experimental scale, is Mr. Falconer, a gentleman who is here this evening, and who has sent here some old anodes of lithanode and peroxide of lead which had been used in a solution of chloride magnesium, and which have been exposed to the solution for a long time. You will perceive that the plates are covered with a white substance which suggests chloride of lead, but that substance is magnesium hydrate. If that magnesia be scraped off, I think you will find that the peroxide underneath is perfectly intact. I have come to the conclusion, and on grounds which seem perfectly satisfactory to myself, that the selection of magnesium chloride as a substance to be electrolysed has been an extremely unfortunate one. I can quite confirm what has been said; I can quite confirm, to the extent of my small experience in the matter, what has been stated as to the abnormal bleaching powers of magnesic hypochlorite. A thing which is quite fatal to the use of this salt as a supplier of chlorine is the fact that at ordinary temperature magnesium hypochlorite has a strong tendency to become converted into chlorate. We were very much surprised to find that there did not seem to be any relation between the quantity of current expended and the quantity of chlorine produced. After a certain strength had been obtained, there seemed, in some instances, to be an actual disappearance of chlorine by the passage of the current, and the solution of the mystery ultimately turned out to be that chlorates were produced at ordinary temperatures in considerable abundance. I think, therefore, that magnesium chloride will have to be given up. In conversation with certain persons who have had experience on a large scale with this electrolyte, I have had my impressions confirmed, for I have heard of failures, considered at the time unaccountable, and which I have no doubt may be traced to this production of chlorates. Outside of the large operations there are a great many small operations, in which electrolysis might probably be advantageously introduced, and I would recommend the younger members of the profession to give attention to this. Their number is legion, but I may quote as instances, the conversion of arsenious acid into arsenic acid, on a large scale; the conversion of ferrode prussate of potash into the ferride, or the yellow prussate into the red; and again the purification of acids, sulphuric acid and hydrochloric acid on a large scale; the separation of lead from sulphuric acid, and iron and zinc from hydrochloric acid.

Mr. E. MAYOR: I would say a word or two with regard to what Mr. Swinburne says in the sentences in which he deals with the metallurgy of copper. He says: "Writers of books on political economy are fond of saying that the chaffering of the market makes people manufacture in the cheapest way," and so on; and at the end of the paragraph he says, "The first manufacturers to take up copper refining by electrolysis on really modern principles have a chance of making fortunes before the market is disturbed." Now, this would really be a most momentous sentence were it not for the fact that some manufacturers have already taken the matter up, and are making fortunes. Some of the oldest copper manufacturers in the country have taken it up precisely on the principles Mr. Swinburne described. I would join, also, with Prof. Perry in the fervent hope that we may have full particulars and costs of all these matters. I am afraid the figures we have had are very academical, because costs are very difficult to obtain; there are a good many difficulties involved in the interference with English custom and prejudice, as Mr. Swinburne says. But the copper makers have really taken this matter up, and, I am in a position to know, with great enthusiasm and energy, and I do not think there is any danger that that particular branch of the electrical industry is in the least likely to fall asleep, for the financial motives are so strong for encouraging the preservation of precious metals from argentiferous ores, that it is so much a matter of self-interest that it should be persevered with.

Mr. FALCONER: I am not in any way connected with the electrical or with the chemical world; but, with Mr. FitzGerald, I have carried out certain experiments, extending over, I think I may say, close upon four years; that that I have brought up here to-night has been in solution at least three years, and I do not think that any member who chooses to examine it, will find that it is injured in any form whatever. I will also say this in the presence of Prof. Perry, who is here, and who gave a very elaborate report with regard to the process, that the lithanode that I used when Prof Perry was present, and made his experiments, was a lithanode that had been in solution for two years. I did not replace one single plate, except when any were broken, and that happened through my very crude arrangement of having a false bottom for the lithanode anodes in the bottom of the bath, and to keep it down, I used bricks, so you may see how crude it was. On one or two occasions the bricks toppled down, and broke the lithanode; those I replaced, but all the others were in solution for about two years. I am sorry to say there is a most unaccountable thing in Prof. Perry's report, that after passing the current for 4,000 ampères, we got what Mr. FitzGerald reckoned as an exact percentage that we ought to have, or very near it; but after driving for another 4,000 hours, what did Prof. Perry find? That it went down to zero. There are only three ways in which that can be accounted for: first, that chlorates were formed in the bath. Mr. FitzGerald tested for chlorates, and found just the barest trace of them; that would not account for the loss of solution. The next thing would be hydrogen coming in with the chlorine. It puzzles me to know how it was that, after 8,000 hours of current, I should go back to zero. Mr. FitzGerald has tackled the right thing when he has condemned in toto the magnesium chloride; it is absolutely useless. My experience, extending over four years, shows that lithanode is indestructible in solution, and I believe that Mr. FitzGerald's theory is perfectly correct—that you can even decompose hydrochloric acid by lithanode without injury.

Mr. SWINBURNE: I would ask Mr. Falconer whether there was oxide of magnesia on the lithanode?

Mr. FALCONER: We constructed the bath in this way: at first our original intention was to put the anodes alongside the bath with the cathode, but Mr. FitzGerald said it would be better to have the anodes at the bottom of the bath with plenty of magnesia on them, and that we carried out. I work with a 300-gallon bath. Unfortunately, the bath was a very rotten affair; the coating got into our solution. I am surprised to hear Mr. Cooper defend so strongly the use of platinum. I can tell you that platinum is attacked by chlorine. Great authority as Mr. Cooper is, I must say that platinum is attacked, and I can prove it. Our connections, if not absolutely insulated, would give way; and if it is so in making simple connections, what must it be where you have a platinum anode? It must give way sooner or later. We found that in practice.

Dr. S. THOMPSON: Mr. Swinburne has not touched on one or two processes which, I believe, are used commercially. I think he does not mention the process of galvanising iron by the aid of a skin deposit of zinc, first of all deposited electrically before the sheets are dipped into molten zinc; it is a process, I think, that is known. Then, again, Mr. Swinburne does not do me the honour of mentioning a process of depositing cobalt; I suppose for the very good reason that it does not come under the head of commercial electrolysis. I wish it did; I wish to make it so. I find from experience that the one white metal which will stand a London atmosphere—fog and the products of combustion—is the metal cobalt. I have in my laboratory articles coated with cobalt that retain their colour marvellously. Had they been coated with nickel they would have been yellow in three months, or if with silver they would have been black in a fortnight; but the one metal that can be deposited and will stand the London climate, is cobalt. Why do not our nickel platers use it? The process is just as simple as nickel plating. Another point I would like to lead to, namely, the circumstance that many of these electro-chemical processes apparently depend upon something not very well recognised by chemists. You have an intermediate action of something in the bath which undoubtedly makes the deposition possible, for a deposit of nickel you have ammonia salts, for a deposit of brass you employ ammonia salts, and in my cobalt process you employ magnesia salts. What have these salts to do with the effect? I believe the explanation is, you have in this intermediate state zinc in a nascent state. Everyone knows that nascent hydrogen has more powerful properties than natural hydrogen; and I believe that other things in a nascent state

have greater properties also. Concerning electro-chemical equivalents, for example, in text-books on such subjects figures are given for electro-chemical equivalents of metals in their different states, of ferrous iron, for example, and for ferric iron. I am not at all sure whether those distinctions are not absolutely absurd; at any rate, they are so in the case of ferric salts. You are not able to get a deposit of iron from ferric salts. What happens is this, before you can obtain a deposit from ferric salt it has to be reduced to the ferrous state, and you only get a deposit from ferrous iron, and not truly from ferric iron. Another point which ought to be borne in mind is the necessary minimum electromotive force to produce any action whatever of a chemical nature. Probably it may make the whole difference between its being commercially valuable and commercially valueless, that you should know that minimum electromotive force in each case. In some cases quite small electromotive forces, small fractions of a volt, are all that is required to carry the process out. There are certain reactions which chemists classify at present as molecular combination, or as some lower kind of chemical combination that have as truly their electro-chemical equivalent in volts as have the more strong chemical combinations. Why, for example, in the deposit of copper, you have the weakening of the solution at one end, and the strengthening of the solution at the other, unless you stir up the liquor mechanically. Apparently something is going on besides the mere transfer of copper from anode to cathode; apparently the solution is carried along in the copper. If you have a reversible reaction it will necessarily have a corresponding electrical equivalent. It is quite possible there are a large number of these chemical reactions. If we are ever to extract gold from sea water it must be by means of some exact electromotive force less than that necessary to electrolyse water, but great enough to separate gold from its chloride. I need not say more upon this head because it is obvious that there must be a number of actions of this kind which merely require to be hunted up. Lastly, I would say a word about processes such as that of hermite, which are cycle processes, where the material goes round and round and is regenerated after being used. The difference between a non-cyclic process and a cyclic process makes all the difference in the world between success and failure. I believe Dr. Hurter's mistakes have arisen very largely at first, undoubtedly, from his not recognising the difference between a cyclic process and a non-cyclic one. Let me illustrate that commercially by another process—the manufacture electrically of chlorate of potash from the chloride of potassium. Take a solution of chloride of potassium and begin to electrolyse it, and you get a certain amount of chlorate from it. But however you go on electrolysing chloride of potassium you cannot get more than a certain percentage, say 20 per cent. converted into chlorate, is that you begin with a saturated solution of chlorine, and electrolyse that, you get what you do not want. People will say—people who do not understand the difference between cyclical and non-cyclical—"What is the use of trying to convert chloride of potassium into chlorate of potash?" The answer is, Convert your 20 per cent., and let that stuff go away from the vat, crystallise it to the least soluble chlorate, let the chloride which is not crystallised back into the vat, and convert 20 per cent. of that. You skim off the cream, as it were, every time, and bring the milk back ready to be regenerated again, and the cream ready to be skimmed off. A cyclical process will pay where a non-cyclical process, possibly, cannot. I wish further to remark that, as in electric tanning—in which electrolysis plays so small a part and electric osmose plays so important a part—so, I believe, there are other cases in which osmose is the important part. For example, it is quite possible to separate to a certain extent animal and vegetable oils from mineral oils, by subjecting them to a species of electrolysis.

The meeting then adjourned.

ELECTRO-METALLURGY.*

By J. WILSON SWAN, M.A.

ONE of the wonderful things about the electro-deposition of copper, and, in fact, any other metal deposited from a solution of its salt in water, is, that bright, hard, solid metal, such as we are accustomed to see produced by means of fusion, can, by the action of the electric current, be made to separate from a liquid which has no appearance of metal about it.

The beginning of every electro-deposition process is the making a solution of the metal to be deposited. I am going to dissolve a piece of copper, the most elementary of all chemical operations, but I want to make it quite clear where the metal to be deposited comes from—to show that it is actually in the solution, and actually comes out of it again; for that is an effect so surprising, that it requires both imagination and demonstration to make it evident. There is a glass cell containing nitric acid. In this I will put a piece of copper; it quickly disappears, and a blue solution of copper nitrate is formed. Now, if I pass an electric current through this solution, or through some solution of the same kind, and immerse in it, a little apart from each other—the positive and negative wires coming from some generator of electric current—this will happen; metallic copper will come out of the solution, and attach itself as a coating to the negative wire, and consequently that wire will grow in thickness. At the other wire—the positive—exactly the reverse action will take place. There, if the positive wire be copper, it will gradually dissolve, and become thinner. The quantity of metal deposited on the negative wire will almost exactly equal the quantity dissolved from the positive, and therefore the solution will contain the same quantity of metal at the end of the experiment as at first, but it will not be the same metal; it will be fresh metal dissolved from the positive wire, and the metal originally contained in the solution will have been deposited as metallic copper.

For the reproduction of fine works of art in metal, electrotype is unapproachable. The extreme minuteness with which every touch of graver or modelling tool is copied by the deposited metal film, separates electrotype by a wide space from all other modes of casting. Even the Daguerreotype image is not too exquisitely fine, for electrotype to copy it so perfectly, that the picture is almost as vivid in the cast as in the original.

It is this quality that has given to electrotype a *rôle* which no other process can fill, and, so far, its practical utility is not greatly dependent on the cost of the current.

One of the uses of electrotype, not greatly affected by the cost of deposition, is that of the multiplication of printing surfaces. In these days of illustrated periodicals, electrotype has come more and more into use for making duplicate blocks from wood engravings, which would soon be worn out and useless if printed from direct. It is also employed to make casts from set-up type, to be used instead of ordinary stereotype casts, when long numbers of a book have to be printed; also as a means of copying engraved copper-plates.

The plates illustrate the method employed at Southampton in the map printing department. The original plates are not printed from, except to take proofs. The published maps are all printed from electrotypes. Here is an original plate—here the matrix, or first electro, with, of course, all the lines raised, which are sunk in the original. The second electro is, like the original, an intaglio. Here is a print from it, and here one from the original plate. Practically they are indistinguishable from each other, and bear eloquent testimony to the wonderful power of electrotype to transmit an exceedingly faithful copy of such a surface.

Nickel has, of late years, come into extensive use for what is termed nickel-plating, as applied to coating-polished steel and brass with nickel. Nickel, not only has the advantage over silver of cheapness, but also, in some circumstances, of greater resistance to the action of the air.

Another metal, usually deposited in the form of a coating, is iron. The electrolytic deposit of iron is peculiarly hard—so much so, that it is commonly, but erroneously, spoken of as *steel*-facing. The deposition of a film of iron upon engraved copper plates, as a means of preventing the wear incidental to their use in being printed from, has become almost universal. Valuable etchings, mezzo-tints, and photogravure plates are thus made to bear a thousand or more impressions without injury. By dissolving off the iron veil with weak acid, when the first signs of wear appear on the surface of the plate, and re-coating it with iron, an engraved copper plate is, for all practical purposes, everlasting.

In this case, of course, the film of iron is extremely thin—one or two hundred thousandths of an inch. But it is possible to produce most of the metals commonly used as coatings, in a more massive form. Here, for example, is an iron rod half-an-inch in diameter, entirely formed by electrolytic deposition. I am indebted to Mr. Roberts-Austen for being able to show this, and also for this other example of a solid deposit of iron, and for this beautiful specimen of electrolytic coating with iron. Here, also, are solid deposits of silver. This drinking cup is a solid silver electro-deposit.

These are all departments of electro-metallurgy which would have maintained a perfectly healthy industrial existence and growth without the dynamo; but now I come to speak of a branch of the subject—electrolytic copper refining—which, without that source of cheap electricity, could not have existed. This is the most extensive of all the applications of electro-chemistry, and is rendering valuable assistance to electrical engineering by the improvement it has led to in the conductivity of copper wire.

One of the results of this is seen in the raising of the commercial standard of electrical conductivity.

Ten years ago, contracts for copper wire for telegraphy, stipulated for a minimum conductivity of 95 per cent. of Matthiessen's standard of pure copper. Now, chiefly owing to electrolytic refining, a conductivity of 100 per cent. is demanded by the buyer and conceded by the manufacturer.

The result of experiment shows that the copper of the 1858 Atlantic cable was extremely bad as a conductor, that in fact it is 150 per cent. worse than the best commercial copper of to-day. In other words, it shows that, in point of electrical conductivity, one ton of the copper of to-day will go as far as 2½ tons of such copper as was used for the cable of '58.

This change is largely due to electrolytic copper refining.

To prepare the crude copper for the refining process it is cast into slabs; these form the anodes. The cathodes are formed of thin plates of pure copper. In copper refining works, an immense number of plates, each having 6 to 10 square feet of superficial area, are operated upon together, in a great number of large wooden vats, containing sulphate of copper solution and a small proportion of sulphuric acid. Electric current from a dynamo, driven by a steam-engine or water-power, is conveyed by massive copper conductors to the vats, arranged in long lines of 50 or 100 or more in series. Thick copper bars connect adjoining vats, and provide a positive and negative support for the plates, which hang in the solution, opposite each other, two or three inches apart. During the process, the impure slabs dissolve, and at the same time pure copper is deposited from the solution upon the thin plates. The deposition and dissolving go on slowly, in some cases very slowly, for a slow action takes less power, and gives purer copper than a more rapid one. The usual rate is 1 to 10 amperes per square foot of cathode surface.

* Abstract of lecture delivered before the Royal Institution of Great Britain, May 20th, 1892.

You will better realise what these rates of deposit mean, when I say that 1 ampère per square foot rate of deposition gives for each foot of cathode surface, nearly one ounce of copper in 24 hours, and a thickness of $\frac{1}{800}$th of an inch; and therefore the production of one ton of copper, at that rate, in 24 hours, would require a cathode surface in the vats, in round numbers, of 36,000 square feet. At the higher rate of 10 ampères per square foot, which is used where coal is cheap, $\frac{1}{10}$th of this area would be required.

The importance of the electrolytic copper refining industry, and the extent of the plant connected with it, may be inferred from the fact that, reckoning the united production of all the electrolytic copper works in the world, nearly one ton of copper is deposited every quarter of an hour.

Very little power is required for copper deposition if the extent of the dissolving and depositing surfaces is large, relatively to the quantity of copper deposited in a given time.

Some of the impurities ordinarily found in crude copper are valuable. Silver and gold are common impurities, and these, and some other impurities, do not enter into solution, but fall down as black mud, are recovered, and go to diminish the cost of the process, or increase the profit; and even those impurities which enter into solution, are, under ordinary conditions, almost completely separated.

Electrolytic copper refining is both an economical and an effective process. The deposited copper is exceptionally pure. At one time it was supposed that it must necessarily be quite pure, but this is not the case; other metals can be deposited with the copper, but it is not difficult to realise in practice a close approximation to absolute purity in the deposited copper. Here is an example of the deposition of a mixed metal—brass, that is, copper and zinc deposited together. These deposits of brass and other alloys show that more than one metal can be deposited at the same time. The great enemy to conductivity in copper is arsenic, and the deposition of arsenic as well as copper, is one of the things to be guarded against in electrolytic copper refining. Not only are the chemical characteristics of electrolytically refined copper generally good, but its mechanical properties are largely controllable. Usually electrolytic copper is melted down and cast into billets of the form required for rolling and wire-drawing. This treatment not only involves cost, but the copper is apt to imbibe impurity during fusion; though, if the process is carefully conducted, the deterioration is slight.

But it is evident that the re-melting of the deposited copper is a thing to be avoided, if possible, and the question naturally arises, why, now that deposition costs so little, may not the beautiful principle which comes into play in electrotype, and which enables the most complicated forms to be faithfully copied, be taken advantage of to give to plainer and heavier objects their ultimate form?

There are several reasons why this idea is not more frequently acted upon. One is, that the process of electrolytic deposition is slow; another, that knowledge of the conditions necessary for obtaining a deposit having the required strength, and other qualities, is not very widespread. Moreover, in the electrolytic deposition of copper, and indeed of all metals, there is a strong tendency to roughness on the outside of the deposit, and to excrescent growths, the removal of which involve waste of labour and material. These tendencies can, to very great extent, be counteracted by careful manipulation, and the use of suitable solutions, and they can also be counteracted by mechanical means. This has been done by Mr. Elmore. He remedies the faults I have mentioned by causing a burnisher of agate (arranged after the manner of a tool in a screw-cutting lathe) to press upon and traverse a revolving cylindrical surface on which the deposit is taking place, and while it is immersed in the copper solution. The result is that it is kept smooth and bright to the end of the process.

But the use of the burnisher is not the only means available for the production of a smooth deposit. It was observed in the early days of electro-plating how great a change was effected in the character of the metal deposited, by the presence of a very small quantity of certain impurities. It was found, for example, that an exceedingly mild dose of bisulphide of carbon, if put into a bath from which silver was being deposited, caused the deposit to change from dull to bright.

I have lately had experience of a similar kind with nickel and with copper. I was working with a hot solution of nickel, and up to a certain point the deposit had the usual dead-grey appearance. Suddenly, and without doing anything more than putting in a new cathode, I found the character of the deposit completely changed. Instead of the grey, tough, adherent deposit, there was produced a brittle, specular deposit, which scaled off in brilliantly shining flakes of metal. I sought for the cause of this extraordinary change, and traced it to the accidental introduction into the solution of a minute quantity of glue.

By adding gelatine to a fresh nickel solution I obtained the same peculiar bright and brittle deposit that had resulted from the accident. I then made a similar addition to a solution of copper, and when I hit the right quantity—an exceedingly minute one—bright copper, instead of dull or crystalline, was deposited. Here are some specimens. They were deposited on a bright surface, and they are bright on both sides.

Not only is the copper made bright, under the conditions I have described, but, if the proportion of the gelatine be carried to the utmost that is consistent with the production of a bright deposit, it becomes exceedingly hard and brittle. Beyond this point the deposit is partly bright and partly dead, the arrangement of the patches of dead and bright being in some cases very peculiar, and suggestive of a strong conflict of opposing forces.

Before I leave the subject of copper deposition, I may mention that I have found the range of current density within which it is possible to obtain a deposit of reguline metal far wider than is commonly supposed.

The rate of deposition in copper-refining is usually very slow, and it is one of the drawbacks of the process, since slow deposition necessitates large plant. But rapid deposition necessitates a larger consumption of power, and larger cost on that account, and therefore, there is a point beyond which it is not good economy to go, in the direction of more rapid deposition. Still there are cases where, if we had the power to deposit more rapidly, it might be found useful to exercise it. The subject of more rapid deposition is also interesting from a scientific point of view, I therefore mention an unusual result I have arrived at in this direction.

Taking, as one extreme, the slow rate of deposit, of 1 ampère per square foot of cathode—a rate not infrequent in copper-refining—I have found that the limit in the other direction is not reached by a rate of deposit one thousand times faster. I have produced, and I hope to be able to produce before you, a perfectly good deposit of copper, with a current density of 1,000 ampères per square foot of cathode.

This cell contains a solution of copper nitrate with a small proportion of ammonium chloride. The plate on which I am going to produce a deposit of copper has an exposed surface of 21 square inches. Opposite, at a distance of 1 inch, is a plate of copper. When I close the circuit a current of 140 ampères is passing through the solution. I continue this for just one minute. Now I wash it, and remove the outer edge so as to detach the deposit, and as you see, I have a sheet of good copper—an electrotype.

To have produced a deposit of this thickness at the ordinary rate used in electro-typing operations, would have occupied more than an hour.

In this experiment an extreme degree of rapidity of deposition has been shown. I do not intend to suggest such a rate as of practical value. But it is at least interesting, as showing that the characteristic properties of copper are not less perfectly developed when the atoms of metal have been piled up one on the other at this extremely rapid rate than when there is slower aggregation.

I think it probable that a rate of deposit intermediate between this rate and the usual one of about 10 ampères per square foot may frequently be useful, for no doubt the slowness of the rate of deposit often prevented electrotype from being made use of, where, if the rate could have been increased 10 times, it might have been employed with advantage.

Here are some thick plates, deposited at the rate of 100 ampères per square foot. They are as solid and as free from flaw as plates deposited 10 times more slowly.

I said that electrolytic copper-refining owed its existence to the discovery and improvement of the dynamo, and that other electro-metallurgic industries had originated from the same cause. One of these industries is the electrolytic production of aluminium.

When Deville produced aluminium by the action of sodium on aluminium chloride, exaggerated expectations were entertained of the great part it was about to play in metallurgy. It was very soon found that aluminium had not all the virtues that its too sanguine friends had claimed for it, but that it had a great many most valuable properties, and, given a certain degree of cheapness, a number of useful applications could be found for it. Some of these are suggested and shown by the various articles made of aluminium, kindly lent by the Metal Reduction Syndicate, and metallurgical research is rapidly extending our knowledge of its importance in connection with the improvement of steel castings, and the production of bronzes and other alloys of extraordinary strength. The cost of the aluminium produced by Deville's process was too great to permit of its use on any large scale for these purposes.

After Davy demonstrated, by the electrolytic extraction of potassium and sodium, the power of the electric current to break down the strong combination existing between the alkaline metals and oxygen, it seemed natural to expect that aluminium would also be reduced by the same means. But Davy did not succeed in producing any appreciable quantity of aluminium by the electrolytic method. Deville and Bunsen were more successful, but they did not possess the modern dynamo: that has made all the difference between the small experimental results they achieved and the industrial production of to-day, a production now so large that I suppose every day it amounts to at least one ton, and has resulted in a very great reduction of the price of the metal.

There are two electrolytic processes at work. One is the Hall process—employed at Pittsburg, and at Patricroft, Manchester—and now in experimental operation here. The other, the Herault process, worked at Neuhausen, is not greatly different from the Hall process—the shape of the furnace or crucible is different, and the composition of the bath yielding the aluminium may be different, but in all essentials these two processes are one and the same. They depend on the electrolysis of a fused bath, composed of cryolite, aluminium fluoride, fluorspar and alumina. In the Hall process this mixture is contained in a carbon-lined iron crucible—the cathode in an electric circuit; and between which and the anode—a stick of carbon immersed in the fused bath—a difference of potential of 10 volts is maintained. In carrying out the process on a manufacturing scale, there are many of these sticks of carbon to each bath. Here, in our experimental furnace, there is only one.

The heat developed by the passing of so large a current as we are using (180 ampères), through an electrolyte of but a few inches area in cross section, is sufficient to melt and keep red-hot the fluorides in which the alumina is dissolved.

The electrolytic action results in the separation of aluminium from oxygen. The metal settles to the bottom of the pot, and is tapped, or ladled out, from time to time as it accumulates. The oxygen goes to the carbon cylinder, and burns it away at about the same rate as that at which aluminium is produced. It is only necessary to keep up the supply of alumina to enable the operation to be continued for a long time. I mean, of course, in addition to the keeping up of the current, and the supply of carbon at the anode.

By far the greater part of the cost of aluminium obtained by electrolysis is the cost of motive power, 20 horse-power hours are expended to produce 1 lb. of aluminium. Therefore it is essential for the cheap production of aluminium to have cheap motive power.

There is one feature about the Neuhausen production of aluminium which is very striking, and that is the generation of the electric current by means of water power derived from a portion of the Falls of the Rhine at Schaffhausen.

The motive for making use of water power is economy. But, apart from that, it is interesting to see water replacing coal, not only in the production of power, but also in the production of the heat required in asmelting furnace.

NEW PATENTS—1892.

19,992. "An electric energy meter." R. PIPPETTE. Dated November 7th.

20,009. "A portable microphone for the improvement of hearing in deaf persons, and adapted both for individual and general conversation." F. SHAPLEY. Dated November 7th.

20,056. "Improved electrical appliance to be adapted to clocks for giving an alarm." V. DURAND. Dated November 7th.

20,057. "Improvements in the construction of phonographs." E. O. KUMBERG. Dated November 7th.

20,064. "An improved method of and means for generating currents of electricity for promoting the growth of vegetation. R. H. COURTENAY. Dated November 7th.

20,065. "Improvements in the construction of horticultural buildings, also with apparatus and means for forcing the growth of vegetation by electricity." R. H. COURTENAY. Dated November 7th.

20,100, "Improvements in and connected with telephone switches." W. A. SHAW and E. A. SHAW. Dated November 8th.

20,214. "Improvements in electrolytical apparatus." A. J. BOULT. (Communicated by O. Knöfler and Fr. Gebauer, Germany.) Dated November 9th.

20,272. "An improved electric billiard marker and pool marker." W. W. G. WEBB. Dated November 10th.

20,284. "Improvements in apparatus for the manufacture of chlorine." P. DE WILDE, A. REYCHLER, and F. HURTER. Dated November 10th.

20,311. "The improved electric engraver." C. E. BRAUN and F. WILDE. Dated November 10th.

20,316. "Improvements in electric lighting." H. CLEGG. Dated November 10th.

20,333. "Improvements in apparatus for protecting transformers and other electrical apparatus from lightning, and from electric currents of excessive strength." C. E. L. BROWN. Dated November 10th.

20,348. "Improved electric battery cells." R. J. BLACK. Dated November 10th.

20,360. "Improvements in electric arc lamps." R. A. GOODMAN. Dated November 11th.

20,371. "Automatic electrical railway signal." A. G. BURRELL. Dated November 11th.

20,415. "Improvements in microphones." J. T. GENT, A. W. STAVELEY, and I. H. PARSONS. Dated November 11th.

20,418. "Improvements in magnetic water gauges." L. KLERITJ. Dated November 11th.

20,445. "Improvements in electric meters." C. RAAB. Dated November 11th.

20,478. "The combined automatic charging switch and cut-out." R. CARRYER. Dated November 12th.

20,488. "Improvements in apparatus for closing an electric circuit by the passage of a locomotive or train over a line of railway, and recording apparatus connected therewith." F. W. WEBB and A. M. THOMPSON. Dated November 12th.

20,489. "Improvements in apparatus for sterilising and oxidising liquids by electricity." A. B. WOAKES. Dated November 12th.

20,505. "Improvements in alternating current motors." W. L. WISE. (Communicated by the Maschinenfabrik Oerlikon, Switzerland.) Dated November 12th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

The Price of all Specifications (old and new) is now 8d. each.

1,050. "Improved means for distributing electrical energy." S. ZIANI DE FERRANTI. Dated January 20th. The inventor uses contact or relay mechanism which when the current in the low tension main is either too high or too low, completes a shunt circuit which puts into operation an electric or other motor to open or close the converter contacts, and cause the switch for the converter contacts as it tumbles over to break the shunt circuit, whilst at the same time another contact in the relay switch is brought into position to be acted upon whenever another movement of the main switch becomes necessary. 18 claims.

3,127. "Apparatus for automatically indicating loss or diminution of current in electric circuits." W. CRUYT. Dated February 20th. The inventor employs an electro-magnet or magnets excited by the current, which is to be kept approximately constant; two armatures controlled by the said magnet or magnets, and provided with resistances which can be varied at will and independently of each other; a pair of ratchet wheels mounted close together on the same axle, but adapted to turn independently of each other, one of the said wheels having parts of its face painted red or with other bright colour, while the other wheel has perforations corresponding in number and size to the coloured parts of the first wheel, so that in certain relative positions of the wheels, the said colour can be seen through the perforations; a pair of ratchet pawls secured to the said armatures and operated by the same in such a manner, that the pawl which is attached to the first armature acts on the first tooth wheel, while the pawl which is operated by the second armature acts on the second tooth wheel, and both tooth wheels are turned in the same direction. As long as the two armatures vibrate in unison, the two tooth wheels turn at the same speed, and there is no relative motion between the same; but if one of the armatures ceases to operate, because the current has become insufficient to overcome its resistance, there will be a relative motion between the two wheels, so that sooner or later the coloured parts of the lower or back wheel will become visible through the apertures of the upper or front wheel. 4 claims.

4,064. "Improvements in electricity meters." G. HOOKHAM. Dated March 6. Relates to that class of electricity meters which consist, essentially, of a motor whose driving moment is proportional either to the current or the electrical energy of the supply doing work against Foucault currents generated in a metallic disc, or other figure of revolution, rotating in a constant magnetic field. 5 claims.

4,306. "An improved method of, and means for, increasing the efficiency of dynamo-electric generators." W. BOGGETT. Dated March 10. Consists in adopting the processes for generating steam described in Perkin's specification of 1839. 1 claim.

5,167. "An improvement in the manufacture of tubes by electrolysis." F. E. ELMORE and A. S. ELMORE. Dated March 23rd. Relates to the preparation of suitable mandrils and means of facilitating the removal of electrolytically-deposited tubes from the mandrils on which they are deposited. 3 claims.

5,342. "Improvements in electrical thermometers or pyrometers." H. L. CALLENDAR. Dated March 25th. Claims:—1. An electrical thermometer, or pyrometer, in which a coil of platinum, or other suitable wire and leading wires, and also compensating wires similar to the leading wires, are enclosed in a tube or case of glass, porcelain, iron, or other suitable material, and in which the measurement of the variation with change of temperature of the electrical resistance of the coil is unaffected by any change which may take place in the leading wires. 2. An electrical thermometer, or pyrometer, in which a coil of platinum, or other suitable wire and leading wires are enclosed in a tube of glass, porcelain, iron, or other suitable material, and are kept in place by threading them through holes in discs of mica, or other suitable insulating and sufficiently refractory material loosely fitting the said tube, as herein described. 3. An electrical thermometer, or pyrometer, substantially as described.

5,947. "Method of and means for renewing or repairing the filaments of incandescent electric lamps." H. CHAPMAN. Dated April 7th. The inventor opens the end of the bulb by removing (by filing or otherwise) the end of the nipple, or he may form an opening at any other suitable part of the bulb. He then withdraws the filament, cleans the inside of the bulb by heating it to nearly or about a red heat, then cuts off the bad or unnecessary part of the filament and replaces the filament in the bulb again and joins it to the conducting wires. He then exhausts the air by means of the mercurial air pump or other such means, and seals the opening or end of the bulb by a gas jet or the like heating means. 3 claims.

6,243. "Improvements in galvanic batteries." S. MARCUS, L. PATZ, and R. GREBNER. Dated April 11th. Consists in giving to the one electrode a cylindrical form, and to the other a prismatic form. 3 claims.

6,247. "Improvements in automatic regulating apparatus employed in connection with galvanic batteries." J. Y. JOHNSON. (Communicated from abroad by F. Gendron, of Bordeaux.) Dated April 11th. An electric device, which is called into operation in the first instance, acts as a regulator controlling the number of cells brought into operation for supplying electric lamps. Whilst these lamps are in action, two pumps, also worked by electricity, produce a constant circulation of the liquids in the battery. After a time, when the liquids become exhausted to such an extent that the original number of elements is insufficient to supply the lamps, another electric regulating device automatically increases the number of elements or cells in the circuit, and repeats this operation as often as required, until all the remaining cells have been successively brought into action. The regulator acts in like manner, also putting more cells into the circuit when the number of lamps is increased. 5 claims.

6,517. "Improvements in electric light switches." C. M. DORMAN and R. A. SMITH. Dated April 16th. Consists principally in mounting the parts of the switch and fuse on opposite faces of an insulating base which projects at right angles from the wall or surface to which the switch is fixed. 6 claims.

6,978. "Improvements in or relating to the automatic regulation of dynamo-electric machines." A. J. BOULT. (A communication from W. Stone, of Melbourne.) Dated April 22nd. Consists essentially in the employment of three brushes or sets of brushes mounted at fixed angular distances apart upon a movable frame connected to the armature of a long-pull magnet or solenoid whose coils are inserted in the main circuit, said brushes or sets of brushes being

so arranged that two of them, which are directly electrically connected together, press upon the commutator one on either side of the diametric line on which the other brush or set of brushes is arranged. 5 claims.

7,283. "An improved system of telegraphy and telephony." A. R. BENNETT. Dated April 28th. When two towns, or other separated points, are connected by an aerial telephonic metallic circuit, the inventor erects from each end of the route, on the same poles and parallel to the general course of the metallic circuit, one or more single wires for a distance which varies with the battery power employed, with the number of single wires erected, and with the distance which separates the single wire or wires from the metallic circuit. When they have been run out from the ends for a sufficient distance supported on any efficient form of insulator, these single wires may terminate either with insulated ends, or by being connected through an electro-magnet or other resistance to the earth. If the single wire or wires at one end of the metallic circuit are arranged so that currents can be sent into them at will from a battery or magneto machine, one pole of which is connected to the earth, and the single wire or wires at the other end of the metallic circuit are connected through a telephone to the earth, the currents from the battery or magneto machine will be heard in the telephone, and telegraphic signals can be transmitted from one single wire, or set of single wires, to the other. The transmission is effected by means of electrostatic induction acting at the one end between the single wire or wires and the metallic circuit, and at the other end between the metallic circuit and the single wire or wires. If telephones or telegraphic instruments are joined in the metallic circuit their operation will not be affected by this electrostatic transmission. 5 claims.

22,820. "Improvements in connection with telephones." E. F. FURTADO and ANDERS, ELLIOT and CHETHAM-STRODE, LIMITED. Dated December 31st. Relates to an individual telephone call. The method, according to and forming the subject of the present invention, is basd upon the following principles:—(*a*) That if a steel reed be set into vibration, and adjusted so as to be in close proximity to a gong or bell, so that at every complete vibration when the fullest amplitude thereof is attained, and the said reed touches or strikes upon the bell, that each stroke is amply sufficient to give a powerful ring thereon. (*b*) That is a given number of current impulses per second be made to pass through an electro-magnet with an armature tuned to give the same number of vibrations as impulses of current per second, then the armature will vibrate in unison with the current impulses. But, on the other hand, if the current impulses are not synchronous with the natural vibrations of the armature, or if the armature vibrations do not form a harmonic to the current impulses, then the armature will not vibrate. 4 claims.

CORRESPONDENCE.

"The Meter for the Million."

The "Writer of the Article" goes very far astray when he says that "to talk of correcting a gas meter for temperature is equivalent to correcting a blacksmith's rule for temperature. The corrections in the latter case is at most ·0011 per cent. per degree cent. In a gas meter it is approximately $\frac{1}{273}$, say, ·37 per cent. per degree cent.—three hundred times as great. The amusing part of the affair is that, while a coefficient of ·38 per cent. in an electric meter is considered a grievous fault, the Board of Trade passes ·37 per cent. in a gas meter as a matter of course.

C. W. S. Crawley.

The incongruous comparison of gas and electricity meters by "The Writer of the Article" on the above subject, is made still more apparent by the inapt illustrations in his letter. I referred to the fact that no simple or cheap gas meter was in general use which made temperature corrections automatically; and he says, "To talk of correcting a gas meter for changes of temperature, is equivalent to proposing to correct a blacksmith's three-foot rule for changes of temperature; no such refinement is necessary."

Here we have the admission that change in the volume of gas (produced by change of temperature) is of no consequence; and it follows that such a gas meter can never accurately measure volume, by which we are charged. Yet this inherently inaccurate meter is held up as a standard of "reliability and perfect fitness for the purpose to which a meter is applied;" not, be it observed, to the readers of a gas journal, but to those engaged in the most refined method of measurement known. Is not this startling?

The cool assumption that I am unacquainted with Patent Office records requires no refutation from me, and I wish to avoid personal matters. Fifteen years is but a short time in which to produce a perfect and cheap meter, when compared with the admittedly inaccurate gas meter evolved from Clegg's of nearly 80 years ago. There are several electricity meters known of very great merit and reliability; but considering the requirements of the Board of Trade, the subtle nature of the force dealt with, the almost practical necessity of using high resistance shunts, and the necessary cost of materials, it is very doubtful if we shall soon see a *cheap* electricity meter in the sense required by "The Writer of the Article." It is a curious illustration that "The grocer's balance and weights are more fit for the purpose" than "a correct, refined, delicate chemical balance would be." If by this is meant that such chemical balances are not to be used for weighing groceries, I agree with it; but if it is intended to mean that grocers' scales are to be recommended to scientific men for highly refined quantative measurement, on the ground of "reliability, and perfect fitness for the work," it is simply amazing!

J. Sinclair Fairfax.

November 21*st*, 1892.

The Electric Light Fatality.

To a steam engineer the recent fatality to a fitter employed by the House-to-House Company appears to be entirely the fault of the company. If any firm of boiler makers, for example, were to send a man to caulk the firebox of a boiler under steam pressure, there would be sufficient evidence forthcoming at the inquest to convict the employer of manslaughter. The coroner's jury, in case of a boiler exploding from such fooling, may in future be expected to add riders to the effect that the caulker himself must have been to blame because he did not wear a dress coat or had not on a wedding garment. Such a rider would be just about as sensible as the rider in the electric inquest, which surely could only have been the outcome of entire ignorance of the subject on the part of the jury, or a curious willingness to be persuaded by the evidence of an interested expert. It may be asked next time a boiler explodes under caulking, "Was it because the seam of rivets had half the rivets missing, or the plate was cracked through the rivet holes and therefore no one was to blame?" Would such a boiler be any safer to caulk under steam if the caulker wore a silk hat? The writer is only a steam engineer, but believes, anyhow, that the sense in handling live cables under a high voltage is about on a par with handling fire-damp in mass with a naked light, or repairing boilers under steam.

High-pressure boilers are safe enough, and so is fire-damp when let out at a proper burner for illuminating purposes, and the folly of handling a live cable lies a good deal in the impression created that electricity is dangerous to use, whereas it is the corporate bodies as allow such follies as have been recorded, who are the dangers to all around them.

W. B.

Train Lighting.

I have read your article upon "Train Lighting," in your issue of the 11th inst., with great interest.

In the course of the next few weeks I trust to be in a position to ask you to be kind enough to attend a test proposed to be made on one of our large railway systems for lighting train carriages by electricity; the method in question obviates, I understand, the dangers so ably set out in your article above referred to.

J. Dunham-Massey.

November 17*th*, 1892.

Schanschieff Battery.

I should be obliged if any of your readers can inform me where the Schanschieff battery can be obtained, and whether it can be got in combination with a miner's lamp, for which, when it was brought out, it seemed particularly adapted.

W. O.

November 19*th*, 1892.

[We would suggest that our correspondent should apply direct to Mr. Schanschieff, as we believe the battery patent is again in his possession.—EDS. ELEC. REV.].

[We have received a lengthy letter from Mr. Arthur Shippey regarding the new Westinghouse lamp, too late for insertion in this issue.—EDS. ELEC. REV.]